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November 9, 1933

Engineering News-Record

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Building Large Earth Dams with C.C.C. Labor

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Composite Floor Slabs of Two Kinds of Concrete

Clear-Span Underpass Near Toledo

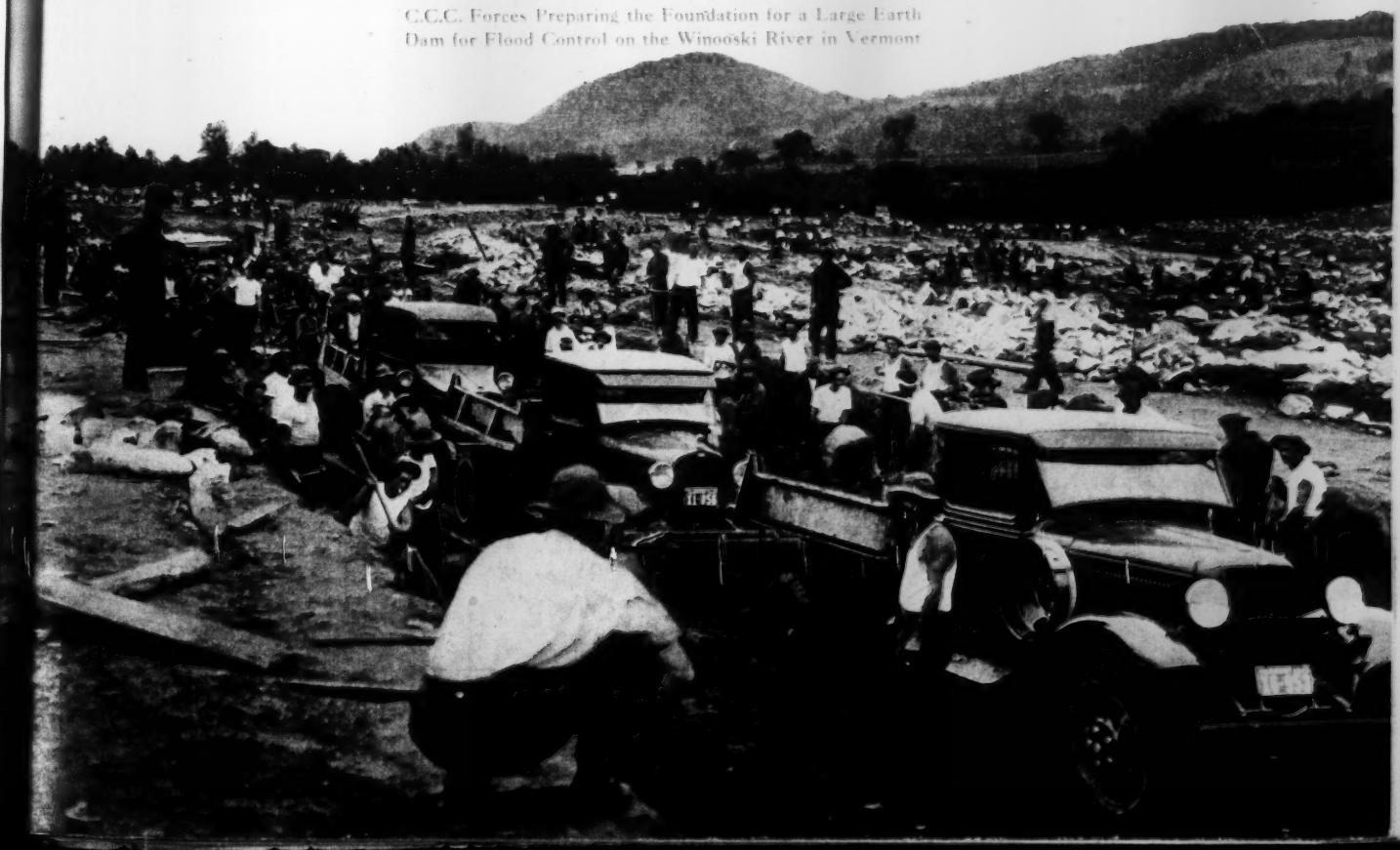
Test Data for Quality Control of Gunite

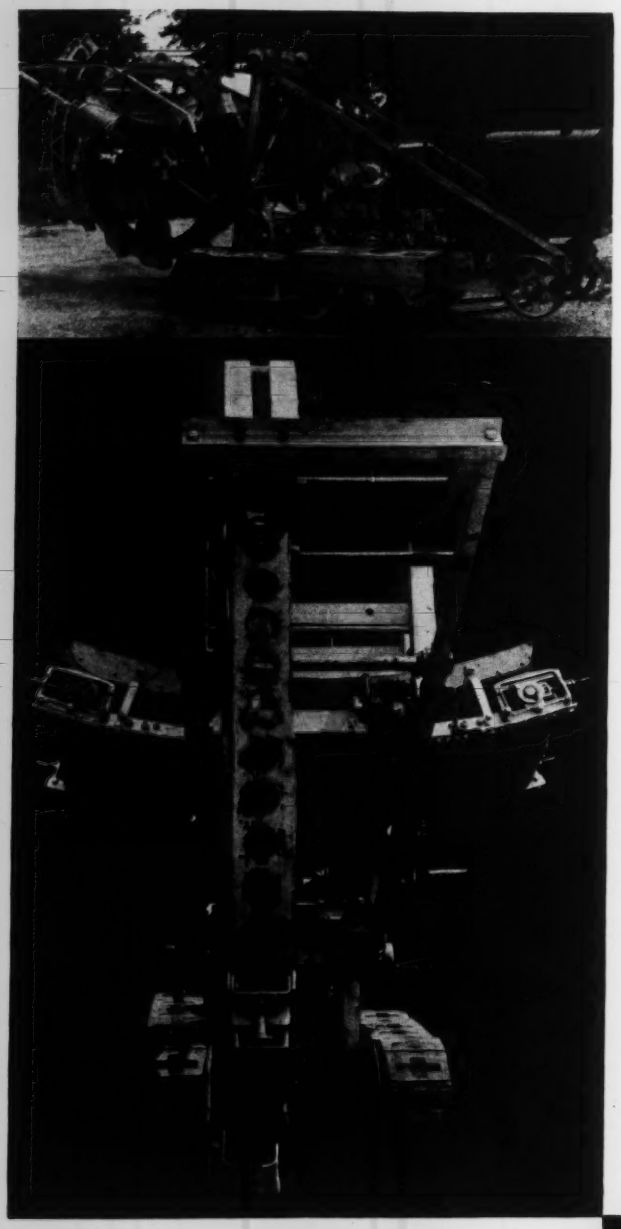
Sante Fe Track Elevation in Oklahoma City

The Bonneville Dam on the Lower Columbia

French Plan Specifications for 36 Cements

C.C.C. Forces Preparing the Foundation for a Large Earth Dam for Flood Control on the Winooski River in Vermont





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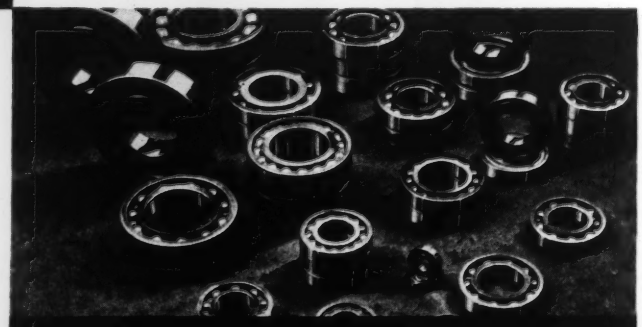

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VOLUME 111, NUMBER 19

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Published every Thursday. Price 25c. per copy. Subscription, U.S.A., Mexico, Central and South American countries, $5 per year. Canada, including duty, $7.50. All other countries, $9 a year, or 45 shillings. Entered as second-class matter April 11, 1917, at the Post Office at New York, N. Y., under the Act of March 3, 1879. Printed in U.S.A. Cable Address "McGrawhill, New York." Member A.B.P. Member A.B.C. Copyright 1933, by

McGRAW-HILL PUBLISHING COMPANY, INC., 330 WEST 42d STREET, NEW YORK, N. Y.

Editorial and Publishing Offices: 330 West 42d St., New York; 520 North Michigan Ave., Chicago; 883 Mission St., San Francisco; Aldwych House, London, W. C. 2, England. Branch Offices: Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Greenville, S. C. James H. McGraw, Chairman of the Board; Malcolm Muir, President; James H. McGraw, Jr., Vice-President and Treasurer; Mason Britton, Vice-President; Edgar Kobak, Vice-President; H. C. Parmelee, Vice-President; Harold W. McGraw, Vice-President; B. R. Putnam, Secretary.

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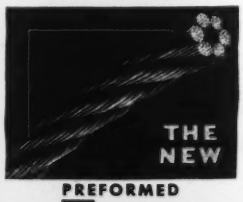

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Engineering News-Record

New York

November 9, 1933

Building Large Earth Dams With C.C.C. Labor

Maximum labor force coupled with judicious use of equipment permits army engineers to make good progress on Winooski River flood-control project in Vermont

MOBILIZATION of 5,000 specially recruited but untrained members of the Civilian Conservation Corps into an organization to furnish the labor for the construction of two large earth dams and other flood-control works on the Winooski River watershed in Vermont was the difficult task that confronted the Corps of Engineers early in July. The C.C.C. organizations selected to furnish the labor consisted entirely of war veterans. The mobilization closely resembled wartime activity in that the commencement of active work and the arrival of the veterans came with practically no warning. No time was available to provide any but minor tools until the work was organized on a definite basis, which, in accordance with instructions, gave full opportunity for hand work, yet permitted sufficient mechanization to enable construction to be carried on with reasonable speed.

As major elements of a rather far-flung series of works for the improvement of a minor river and because of the unusual working methods necessarily being followed in construction, these dams have exceptional interest to engineers. As part of a comprehensively planned undertaking in river control and development, the new dams are technically important.

The Winooski project

The Winooski project is the result of one of the surveys and studies conducted, by direction of Congress, by the engineers of the army of numerous streams of the United States, with consideration given to four features: navigation, flood control, power development and irrigation. The first and last of these do not apply in the case of the Winooski. The Vermont floods of November, 1927, in which the Winooski River was a disastrous participant, called special attention of the country to the conditions in Vermont. The state created an advisory committee of engineers with which the district engineer of the U. S. Engineer Corps worked in developing the studies and plans. These were reported by the district engineer in December, 1930, and recommended limited participation by the federal government in the expense of carrying out the planned project. In reviewing this report the Board of Engineers of Rivers and Harbors and the Chief of Engineers approved the plan as technically adequate, but reported that financial participation by the federal government was not economi-

Fig. 1—C.C.C. labor in action at East Barre flood-control dam, Vermont. Trucks are lined up in a trench that is being dug for a concrete diversion and discharge conduit. Wheelbarrow crews in background are stripping topsoil from dam site.

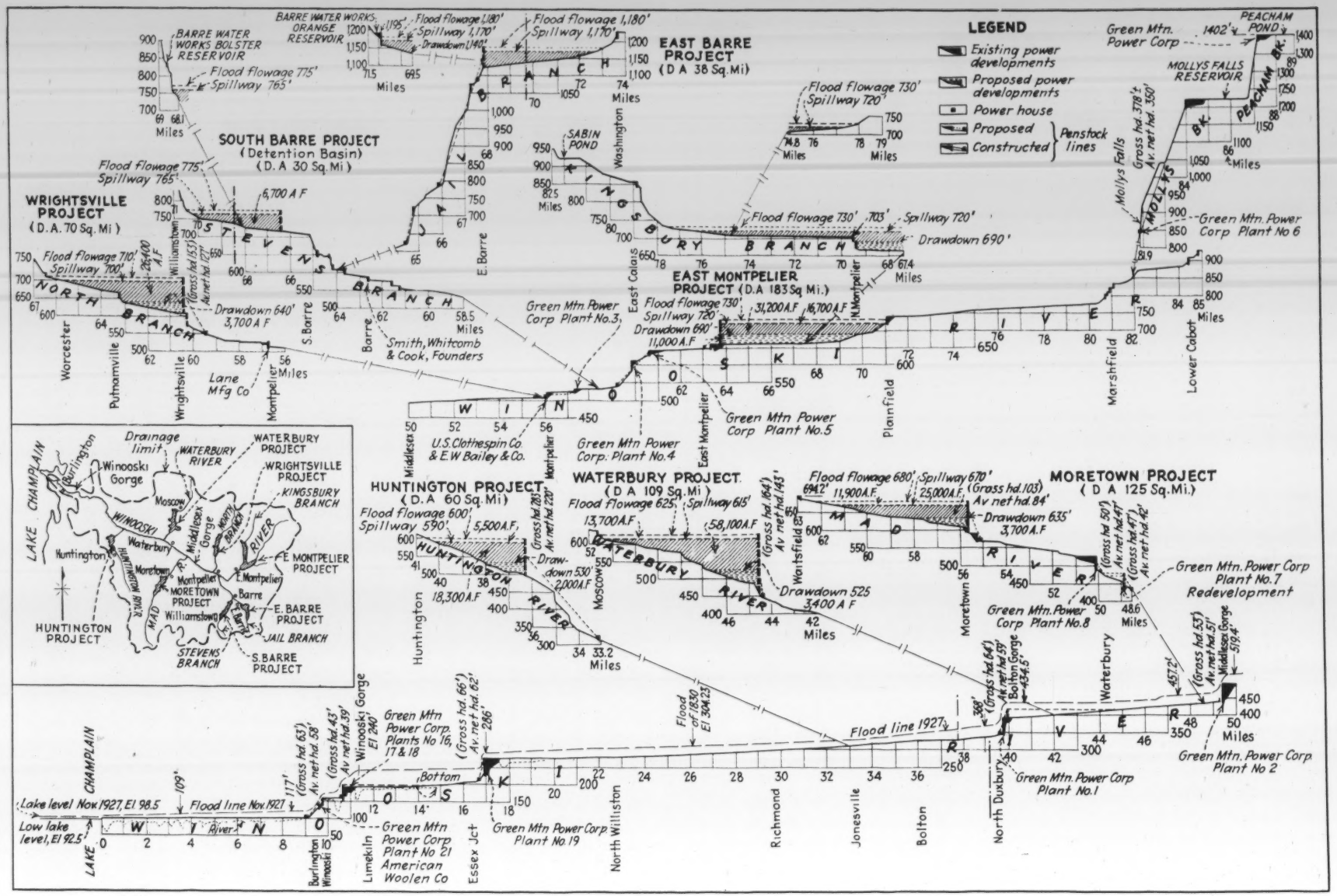


FIG 2—COMPREHENSIVE SCHEME OF FLOOD CONTROL FOR WINOOSKI RIVER

Of the seven flood-detention and power reservoir projects, three were selected for immediate construction by C.C.C. labor: East Barre and Wrightsville dams are under construction, and the South Barre project is waiting on state authorization.

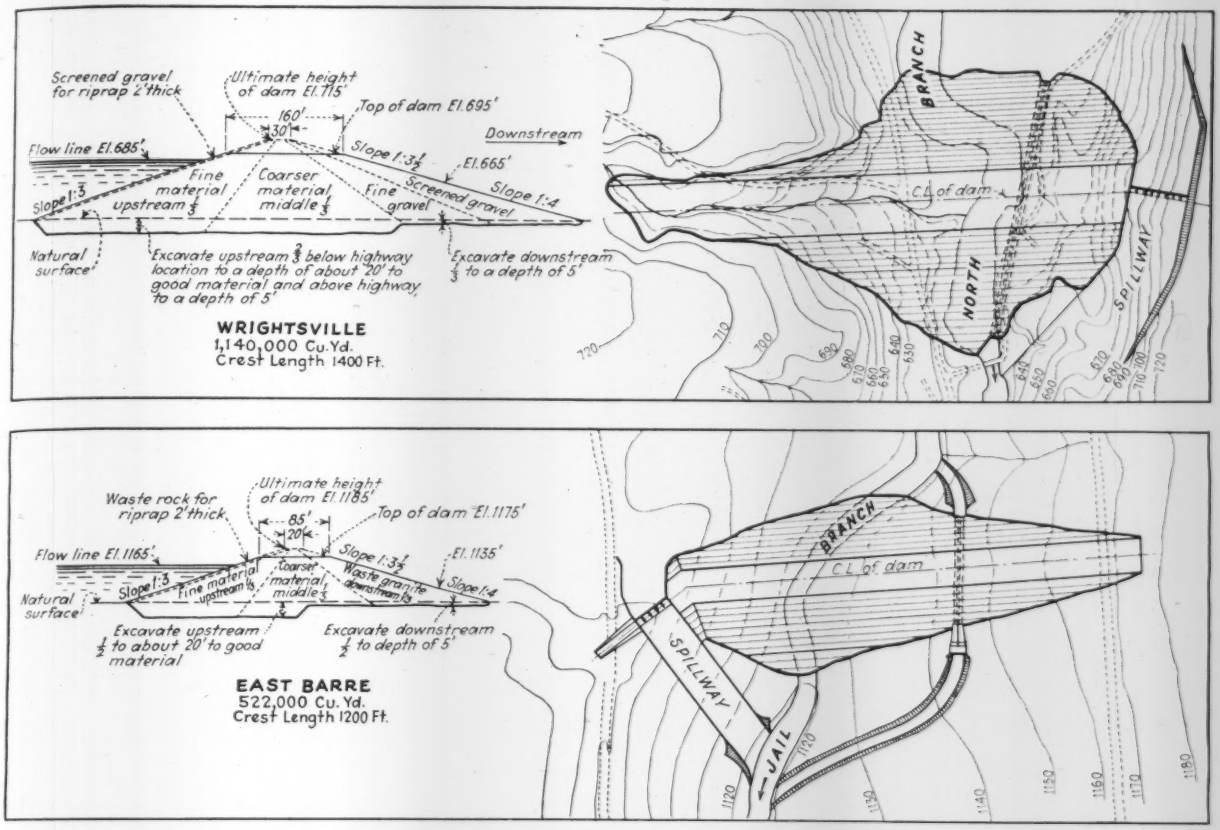


Fig. 3—The Wrightsville and East Barre earth-fill dams will rank as major engineering structures. Fill material will be graded as shown in cross-sections. Concrete conduits will be placed through the structures to serve the stream diversion during construction and as permanent flood-discharge outlets.

cally justified. These reports were made in February, 1931.

Explanation of the present undertaking in the face of these adverse reports is found in the call of President Roosevelt, early in his administration, upon the Chief of Engineers to present a list of flood and river-control projects that might be undertaken at once to furnish employment. In this list was given the Winooski River project. The manner in which it came to be promptly selected is explained later in describing the construction procedure adopted.

The plan of improvement as reported by the district engineer in his 1930 report was, as shown by the map and group of profiles of Fig. 2, to build a series of combined flood-detention and power-development reservoirs. The Winooski River, as shown by the map, lies wholly in the state of Vermont and has a fall of 825 ft. in 90 miles. The average flow is 1,800 sec.-ft. During the flood of November, 1927, the flow was estimated at 113,000 sec.-ft. There now exist on the river and its tributaries twenty power plants with a total capacity of 33,000 hp.

The proposed comprehensive plan of development provides seven reservoirs with a total capacity of 272,000 acre-ft., about one-quarter of which will be reserved solely for flood control. The engineers found that suitable control over the total storage would regulate the flow of the stream for power development and reduce the floods sufficiently so that they could safely pass through an enlarged channel. They proposed the development of additional power in seven new plants and the enlargement and improvement of twelve existing plants to aggregate a total of 94,000 hp. This development would produce about 167,000 kw.-hr. of new primary power annually. The estimated cost of the complete improvement was: reservoirs, $9,800,000; channel enlargement, $200,000; power installation, $6,100,000; total, $16,100,000. The accompanying table gives the essential elements of the reservoir projects.

Under the present curtailed plan for relief work the reservoir dams at Wrightsville on the North Branch and at East Barre on the Jail Branch have been put under construction, and the dam at South Barre on the Stevens Branch awaits authorization by the state of Vermont before it can be undertaken. Present indications are that this authority will not be given, at least for the time being. These three dams partially control the flood conditions at Montpelier, the state capital, and in the group of towns of which Barre is the center. Complete protection would also require the construction of the East Montpelier dam, one of the seven proposed in the complete development. Reasonable, though partial, protection to this area, however, would require the operation of all three of the dams (East

CHARACTERISTICS OF THE SEVEN FLOOD-CONTROL PROJECTS RECOMMENDED FOR THE WINOOSKI RIVER

No.	Stream	Drainage Area (Square Miles)	Storage (in Acre-Feet)			Construction Cost		
			Power	Flood	Total	Reservoirs	Power Plants	Total
1	Winooski River	183	42,200	16,700	58,900	$2,192,766	$245,537	$2,438,303
2	Jail Branch	38	15,300	7,900	23,200	1,003,091	581,027	1,584,118
3	Stevens Branch	30	0	10,000	10,000	687,096	209,567	896,663
4	North Branch	70	30,200	8,100	38,300	1,342,280	334,249	1,676,529
5	Mad River	125	28,700	11,900	40,600	924,750	308,648	1,233,398
6	Waterbury River	109	61,500	13,700	75,200	2,357,601	294,998	2,652,599
7	Huntington River	60	20,400	5,500	25,900	1,232,136	625,783	1,857,919
	Total	615	198,300	73,800	272,100	9,739,720	2,599,809	12,339,529

Fig. 4—Scene of typical action found at East Barre dam in early stages of work before major equipment was installed.

Barre, South Barre and Wrightsville) as a unit, and therefore the delay in approving the South Barre dam is giving some concern.

Planning for hand labor

With the designation by the Chief of Engineers of the three dams named as available for immediate construction employment, the proposal was made by the director of the C.C.C. to use some of these units for the dam work. Subsequently this proposal was modified by the administration at Washington to employ, in the place of regular C.C.C. men, special units recruited from unemployed war veterans. The construction work was to be so planned as to use a maximum of hand labor. At present about 5,000 men have been moved to the operations since the work began in July, 1933.

Following the decision of the Washington administration to undertake construction by C.C.C. labor, agreemnt was made with the state authorities that Vermont would provide the necessary land and rights-of-way for dam and reservoir sites. Governor Wilson called a special session of the legislature, and on July 20 this session passed a law creating a public-works board. At the same time funds were appropriated for the purchase of the sites of the three projects mentioned above.

The state of Vermont, apprehensive of what would happen to these projects if the scheme of using C.C.C. labor should be abandoned before the jobs were completed, was assured by the federal government that the dams would be completed by other federal funds. From the public-works fund $1,500,000 has been appropriated to be held in reserve for the completion of the dams. As it is not known when the C.C.C. labor and funds may be withdrawn, it is impossible to tell how much of this reserve will be needed, but it is certain that unless the dams are at least half completed by the C.C.C., this amount will not be sufficient to complete the projects.

In addition to the construction of the three dams, the plans provided for clearing out and enlarging six channel sections of the river to provide an unobstructed floodflow. This type of work was especially needed at Middlesex Gorge, near Waterbury, where 10,000 cu.yd. of rock is being removed to provide a wider and unobstructed channel flow. Another narrow channel section of the river through the city of Montpelier is being widened out. One or more small existing dams on the Winooski are to be rebuilt, because they now constitute obstructions to free floodflow. The army engineers estimated that the amount of channel improvement work to be done would cost about $100,000 under normal conditions. Clearing out of flood debris as well as of much refuse dumped into the stream by private manufacturing companies is also necessary.

While the army engineers' recommendations and the early report called for a combined flood-control and power project at each of the seven sites, the present two dams are being built as flood-control dams only, and the crest will be left 20 ft. and 10 ft. below ultimate height at Wrightsville and East Barre, respectively. There will be no control works placed in the dams; instead a concrete conduit will be built within the structure to carry the normal streamflow, any flow in excess backing up and filling the reservoir until the flood recedes. Fig. 3 shows plans and sections of the dams and gives the major characteristics.

Construction procedure

Inasmuch as these projects provide excellent examples of the use of a maximum of hand labor on major engineering structures, an editor visited the work on two occasions, once just after the start of work at the East Barre dam, and again when the East Barre project was well under way and work had been started at Wrightsville dam, at Middlesex Gorge and at Montpelier. Full study was made of the operations to ascertain the organization for managing the work and to appraise the efficiency of the working forces. The following comments are based on the two personal inspections of the work.

The Corps of Engineers is directing the construction work, plans for which were prepared under the supervision of the first district engineer, New York. A civilian engineer is in charge of all construction. Working with him is a major of engineers, assistant to the district engineer, who is in charge of the Vermont office and coordinates the work and supply of the jobs. Construction superintendents hired by the district engineer are in immediate direction of each job. The Corps of Engineers supplies all materials for construction, including cement, sand and coarse aggregate for concrete, equipment and other appurtenances. For this purpose the corps is allowed expenses not to exceed 90c. per C.C.C. man per day for administration, materials, tools and all equipment. Heavy equipment, such as trucks, draglines, air compressors and mixers are being rented as needed rather than purchased outright, rented equipment being supplied on a low-bid contract basis.

Work started with a rush, even before proper and adequate tools were available to permit effective hand work. The conditions under which the army engineers carried on the early part of the work were most discouraging. Disciplinary authority, usually available for troop work, or the right to hire and fire as on civilian work, were lacking. The C.C.C. men were not over-enthusiastic about working. Conditions improved, however, as power equipment was introduced; getting away from wheelbarrow work seemed to be most effective. Encouraging progress is now being made, though it is readily admitted that the efficiency usually present in building large engineering structures is not in all cases being attained. However, the original purpose of the work was to alleviate unemployment, and this purpose, undoubtedly, is being accomplished.

East Barre project

About 1,100 men were assigned to the East Barre project. As is customary on all C.C.C. work, the regular army had charge of these men, who were divided into companies of about 200 each. Tent camps were set up under the direction of the army officers, resulting in excellent sanitary conditions around the camps. The army feeds and clothes the men and looks after their physical welfare. Each man is paid $1 per day, in some cases $35 and $45 per month, in addition to receiving food and clothing, regardless of the number of days worked per month.

Under the original set-up, the army officers who had charge of the camps retained supervision of the men when they reported to the army engineers each day at the jobs. The officer in charge of each company brought his men to the site and remained with them throughout the day. The civilian engineer (under the army engineer) and his superintendents laid out the work to be done. Their orders, however, had to be transmitted through the camp commanders to the organizations. These company commanders then relayed the orders to the leaders of the squads. Under these leaders were assistant leaders. Both

leaders and their assistants were picked from the C.C.C. personnel. This set-up was cumbersome and unsatisfactory. The regular army officers with the C.C.C. units were, in general, not qualified to act as technical supervisors. The C.C.C. men plainly indicated that they did not intend to overwork, and lack of positive authority on the part of anyone on the job fostered this attitude. As stated below, a better set-up was devised and is now in force.

The first work to be done was clearing and grubbing of the dam site, removal of a large number of boulders and stripping of the top soil. At its best, hand labor on such work is very ineffective. Under the conditions obtaining, it was wholly so. The men were lined up in squads to perform definite operations, but there the authority seemed to end. One company of negroes worked with a will at heavy work, such as removing large stumps with block and tackle and hand-drilling large boulders; the remainder of the companies took it more easily from morning until night. The main item of the preliminary work was the stripping of the site and the excavation of the trench for the stream diversion and flood-discharge concrete culvert. Crews with shovels and wheelbarrows were spotted all over the site, but hardly anyone worked. Wheelbarrow runners spent most of the time sitting on the handles of the barrows and talking with the men supposed to be loading them. Despite frequent trips to each gang by a waterboy, the men would line up an hour at a time waiting to get a drink from the water wagon. The presence of the usual number of agitators and troublemakers among the gangs accentuated the difficulties.

Estimates made of the amount of work done in the early stage of the East Barre project, with approximately 1,000 men at work (about 100 men were kept in camps for camp duty), placed the amount of excavation moved daily at 400 cu.yd. This represented practically no progress, since the East Barre dam requires 135,000 cu.yd. of excavation and 390,000 cu.yd. of fill. The first move toward a better set-up on the part of the Corps of Engineers was the introduction of major pieces of equipment. Air compressors and pneumatic rock drills were installed to facilitate removal of boulders. A dragline or two was brought on the job for the heavy excavation work. Small dump trucks replaced wheelbarrows on the long hauls of excavated material. Tractors were used to facilitate stump and boulder removal. Later crawler trucks were introduced for some of the heavy hauling work. The psychological effect of the introduction of power machinery was excellent and immediate. The men at once felt that they were working on a real job.

The introduction of equipment was part of a well-planned move to expedite progress and still keep all of the men at work. The draglines pile the excavated material in a position for easy loading into trucks by hand. Wheelbarrows were dispensed with so far as practicable, being used only where haulage by truck was not feasible. Work is being rushed on the discharge culvert to enable the concrete to be installed before cold weather.

An executive order discharged all C.C.C. workers on Oct. 1, with opportunity provided for re-enrollment for six months. Those who did not re-enroll immediately, but left the work, were not permitted to come back. About 20 per cent of the original personnel failed to enroll again. Prior to the new enrollment of the C.C.C. men, the army engineers had completely reorganized the management of the job. Under the new set-up, the regular army camp officers have charge of the men only when in camp and in going to and from the jobs. Once the men arrive at the work they are turned over to civilian foremen who have real authority over them. If a man now refuses to work, he can be discharged and is not permitted to re-enroll. Trouble-makers and agitators have been weeded out of the gangs, resulting in a vastly improved morale. An effort was made to select foremen from the ranks of the C.C.C., and a number have been found well qualified. The placing of the men directly under the superintendents has given the engineers an effective control of the work. With this control, coupled with the new attitude of the workers themselves, the labor organization is approaching, but has not reached, the efficiency that could be secured from a gang of hired construction workers on this class of work. It is estimated that about 75 per cent of the men are now trying to turn out a full day's work.

Work will be continued on all jobs throughout the winter. Permanent wooden barracks are being erected at the camps for winter occupancy. At the East Barre project most of the winter work will consist of removing waste

Fig. 5 (above)—Great quantities of boulders must be removed in site-stripping operations. This view shows C.C.C. labor working at one abutment of Wrightsville dam. Clearing for other abutment can be seen in the background.

Fig. 6 (below)—Stripping topsoil prior to removal of rock ledge that has obstructed floodflows in the past at Middlesex Gorge. Channel here is being widened, and excavated rock is used to good advantage in providing revetment upstream.

granite from near-by quarries for use in the downstream third of the fill.

Wrightsville project

The Wrightsville project, the larger of the two dams, was started about one month after the start of work at East Barre. About 3,000 men were brought into three camps located near this job, and a construction superintendent was placed in charge. A month's experience at East Barre was used to good advantage in getting the Wrightsville job off to a better start. Major equipment was brought on the job immediately, to be used along with the hand-labor operations. The Wrightsville site was covered with heavy timber requiring considerable clearing. This was, of course, an ideal hand-labor job, and appreciable progress could be noted by the men as clearing extended into the heavy forest, which gave the workers a feeling of accomplishment.

The same reorganization as was put into effect at East Barre also took place at Wrightsville. In addition to hiring of construction foremen, some experienced workmen, such as powder men and carpenters, were hired for key positions to work with the gangs.

Among the early operations at Wrightsville were the removal of numerous existing buildings and the relocation of a highway. Stripping operations followed close upon the clearing and grubbing work. The Wrightsville dam is in a deep valley, flanked on one side by a very steep rocky hillside. The spillway channel will be excavated out of solid rock. Plans are being made to rush the stream diversion and discharge work to completion before cold weather sets in. Most of the winter work will consist of excavation of rock in the spillway and in the preparation of gravel fill for the lower part of the dam. The Wrightsville project involves 254,000 cu.yd. of excavation and 1,150,000 cu. yd. of embankment, with 8,000 cu.yd. of concrete in the spillway and outlet works.

Middlesex Gorge

A separate camp was established at Middlesex Gorge, near Waterbury. There is only one company of men in this camp, and work from the start has been proceeding in a satisfactory manner. Most of the work here consists of drilling, blasting and the removal of solid rock ledges to enlarge the channel section of the river. An expert powder man is in charge of blasting work. The men on this particular project have always had a different attitude from that of their fellow workers on the two dams, and as a result the progress being made is all that could be expected from any hand-labor operations. Air compressors and pneumatic drills are being used where possible, and trucks are being used to a small extent in removal of the blasted material. Most of the excavated material is being moved upstream to form a rock revetment to protect the banks in times of flood.

Work of widening out the channel at Montpelier and removal of refuse dumped into the stream by near-by manufacturing concerns are being done by squads from the camps set up within the city limits. This work is mostly hand-shovel and wheelbarrow operation.

Plans call for the rebuilding of three small dams on the Winooski, all privately owned. Before any work can be done by C.C.C. labor on these dams, it is necessary that the owners deed the structures to the city, making them public property. To date, only one of these three dams—that of the U. S. Clothespin Co., at Montpelier—has been transferred to the city. This dam is now being rebuilt by C.C.C. labor, work consisting principally of strengthening and raising the old concrete structure and the installation of tainter flood-control gates.

The engineering and construction personnel of the work is as follows: Col. G. R. Lukesh, district engineer, First District, in actual charge; Harold E. Libby, civilian engineer, in charge of design and construction; Major E. B. Gesler, assistant to the district engineer, engineering officer in charge of the Montpelier office; J. V. Downing, superintendent at East Barre; C. R. Moore, superintendent at Wrightsville; A. K. Johnson, superintendent in charge of channel clearing; and H. C. Byrnes, superintendent at Middlesex Gorge.

Work Begun on Bonneville Dam on the Lower Columbia River

Army engineers to build combined power and navigation project across the Oregon-Washington boundary at the head of tidewater—Power plant will be second on the Columbia River to be financed by PWA

ALLOCATION of $20,250,000 for the Bonneville Dam from PWA funds to the War Department early in October makes possible the first federal power development on the Columbia River. Previously, $63,000,000 was tentatively allocated to the Columbia Basin Commission (a state body) for power development on the Columbia at Grande Coulee in Washington.

The site chosen for the power development in the lower river is at Bonneville, at the head of tidewater, approximately 40 miles east of Portland, Ore. Here, in a comparatively narrow gorge, Bradford Island divides the river into two channels and provides a site that has been selected by the army engineers as the most feasible on the lower river for power, navigation and flood-control development. No irrigation is included in the project.

Power-development plans call for the initial installation of 90,000-kw. capacity in two units of 45,000 kw. each. Foundations will be provided in the power house for four additional units of equal capacity with space left for a total of ten or possibly twelve units, giving a possible ultimate maximum of 540,000 kw. Barge navigation facilities are to be provided by locks, and the site permits later construction of locks for ocean-going vessels if it is decided to put them in.

Actual work at the site was commenced within two weeks after the appropriation through awarding of a contract for diamond-drilling and other exploration of the site to Fred P. Cannon, Compton, Calif.

Mean low water at the tailrace of the proposed power plant is at El. 10. The dam will establish the water level above at El. 72, thus creating an over-all maximum head at the power plant of 62 ft., and 60,000 acre-ft. of effective pondage for power. The slack-water pool created will be about a mile wide and will extend for a distance of about 50 miles upstream to the lower end of the Dalles-Celilo canal, a short distance above The Dalles, Ore. It will drown out the present rapids just above the dam site, now partly skirted by the Cascade Locks, a government project of the late 80's and early 90's, also a stretch of narrow river and fast water at The Dalles, from which that city derives its name. This change in water level will necessitate relocation of 7 or 8 miles of the S.P.&S. Railway on the north, or Washington, bank, 5 miles of O.W.R. &N. Railway on the Oregon bank, and a total of 5 miles of the famed Columbia River Highway in scattered locations.

River flow ranges from 50,000 sec.-ft. to a recorded maximum of 1,170,000 sec.-ft., the average discharge being 200,000 sec.-ft. Flood season at Bonneville lasts about two months from May into July.

The main dam will consist of four separate structures, fitting into the configuration of the river bed at the site, the chief feature of which is Bradford Island, about a mile long, extending

Brubaker Aerial Surveys

Site of the proposed Bonneville Dam on the Columbia River, about 40 miles east of Portland, Ore. The picture was taken looking upstream, with Washington on the left and Oregon on the right. In the middle background, just ahead of the narrow bend in the river, are the towns of Stevenson, Wash., and Cascade Locks, Ore. In the center is Bradford Island, which will be made an integral part of the dam. The Washington channel will be closed near the head end of the island with a spillway, and the Oregon channel will be closed at the lower end of the island by the power house. Along the island will be an Ambursen-type dam and an earthfill dike. Bonneville itself is on the low-lying flats below the island on the Oregon shore. It consists only of the railroad and a few buildings, including a state fish hatchery.

laterally with the river and dividing it into two channels. The dam proper will consist of an ogee spillway section, 700 ft. long across the main channel from the Washington side to Boat Rock near the head end of Bradford Island, and 600 ft. across Boat Rock. The spillway section will carry 22 lift gates, each 50 ft. long, with a total discharge capacity of 1,400,000 sec.-ft. From the spillway an Ambursen type, non-overflow structure, 1,200 ft. long, will parallel the river to a high point on Bradford Island. West of this high point will be an earthfill, covered by a concrete slab for protection against erosion, extending about 2,650 ft. laterally along the island to a point near its lower end. From there to the Oregon shore, crossing the other channel, will be set the power-house structure, with room for from ten to twelve 60,000-hp. propeller-type water wheels.

At the extreme western end of the power house and along the Oregon bank will be built tandem barge locks 56 ft. wide, 400 ft. long and 12 ft. deep, providing a maximum of 67-ft. lift. Intake to the power house will be via the south or Oregon channel, for easy access to which considerable excavation will be necessary opposite the lower end of Bradford Island. It is expected that foundations for the spillway section of the main dam may go to El. —110.

The total cost of the project is estimated at $31,000,000. This is expected, locally, to come from an out-and-out federal grant for rivers and harbors improvement, and as such it will not need to be liquidated from power earnings. The project is looked upon as presenting an opportunity for securing large power-using industries in the chemical and metallurgical fields heretofore not found in that section of the country. Its location on tidewater and its consequent availability to ocean-going transportation is assumed to be a factor enhancing the economic possibilities of the development.

Personnel

The present construction operation is in charge of Major Charles F. Williams, Corps of Engineers, U. S. Army, under Lt.-Col. Thomas M. Robbins, division engineer of the Pacific Division, San Francisco. Lt. Joseph S. Gorlinski is in immediate charge of administrative affairs.

The chief civilian engineer is Claude I. Grimm, whose offices have been established in Portland, Ore. D. C. Henney, Portland, and L. F. Harza, Chicago, will act as consultants.

Cost of Making Alum at Kansas City

At the alum-manufacturing plant of the Kansas City, Mo., water department during the year May, 1931, to April, 1932, inclusive, it cost $42,707 to make 5,308,110 lb. of aluminum sulphate. The costs of the various items of expense entering into the manufacture of this waterworks chemical are tabulated below, quoted from the annual report of the water department for the year in question.

Bauxite	$ 9,506
Sulphuric acid	23,086
Lime	108
Operating labor	4,092
Maintenance labor	1,094
Maintenance material	444
Depreciation of plant	2,020
Interest on investment	2,104
Power	250
Total	$42,707

To make 5,308,110 lb. of alum, 1,742,345 lb. of bauxite was required, together with 3,032,940 lb. of sulphuric acid and 27,100 lb. of lime.

New Test Data Aid Quality Control of Gunite

Tests conducted in relining reservoirs for Syracuse, N. Y., provide basic data on nozzle velocities, size and shape of test specimens, and cement ratio and water content of mixes

By E. P. Stewart
Dept. of Engineering, Division of Water, Syracuse, N. Y.

THE RATIONAL CONTROL of mixtures of hydraulic cement and aggregates has been extended by the development of basic data on the constitution and application of gunite. Extensive studies made in connection with the relining of two reservoirs of the Syracuse, N. Y., waterworks have given data of value on nozzle velocity, bulking of sand, cement ratio, water content, age of dry mix and strength. In particular, the study of the important factor of nozzle velocity has been extended to positive determinations of velocities for nozzles of different sizes. —EDITOR.

WOODLAND RESERVOIR of the Syracuse (N. Y) water supply is a kidney-shaped structure 1,737 ft. long and 406 ft. average width. At the maximum depth of water of 36 ft. it holds 125,000,000 gal. The side slopes are 1 on 2. It was constructed in 1892-'95. After a year in operation it was emptied and cleaned (1896), presumably to eliminate algae tastes. From that time it was never emptied again until 1932, when the relining work discussed in this article was undertaken. Based on successful results with the previously lined Westcott Reservoir (*ENR*, Nov. 19, 1931), a 1½-in. gunite lining was adopted.

The original lining consisted of a 9-in. course of hand-mixed concrete on the bottom and up the slope to the berm. On the berm the concrete was thickened to 12 in., and on the upper slope it was 6 in. thick with a 12-in. paving of limestone laid in mortar. No construction or expansion joints had been provided; each day's pour of concrete had been joined to the preceding day's work in irregular lines without special effort to secure bond. An examination of the lining showed little actual concrete disintegration, but the concrete was quite porous. There were many separated construction joints and some settlement cracks. At the angle of the lower slope with the berm and the full length of the berm was a crack ⅛ to 1½ in. wide caused by settlement of the upper slope.

New lining

The necessity for relining came from a serious leak that occurred in January, 1932, at a point where the embankment is about 40 ft. high. As stated, a 1½-in. layer of gunite was adopted. The reinforcement was 4x4-in. mesh, No. 7 galvanized and electrically welded steel wire. It was fastened to the old lining at regular intervals with ¼-in. expansion bolts. During the first part of the work the mesh was held up ¾ in. from the old lining by the nozzleman's helper while some gunite was shot under the wire at several points. Later, small stones about ¾ to 1 in. thick were put under the wires. Where the side slopes meet the bottom, an extra thickness of gunite was shot. This was doubly reinforced by lapping the bottom mesh over the slope mesh for 1 ft. or more.

Two types of expansion joints were used. At the inner edge of the berm (the edge nearest the center of the reservoir) the settlement crack mentioned above was cut out to V-shape and covered with a strip of mesh and a batten of gunite about 3 ft. wide, and mopped with hot pitch, which hardened to form a smooth, glossy surface. The gunite lining was placed continuous over this batten and pitch. Fig. 1 shows this construction, which allows for movement of the berm slab and slope lining beneath the gunite as the gunite lining floats on the layer of pitch.

Five expansion joints running across the bottom of the reservoir up to the berm, about at right angles to the center line, and one joint running longitudinally about midway between the sides were constructed, copper expansion stops and pitch being used. These joints, which were about equally spaced, did not run in continuous straight lines, as existing cracks and construction joints were taken advantage of as much as possible. Where neither joints nor cracks existed, a joint was formed by cutting through the old lining with an air hammer. Expansion joints in the gunite lining were constructed above these joints in the concrete, as shown in Fig. 2. The copper strips were soldered except where they crossed at right angles, when they were lapped, with a layer of plastic between them. These joints were difficult to make and required care and supervision to insure good construction.

It was decided to rent equipment and construct the new lining with city forces. The Cement Gun Co., of Allentown, Pa., was low bidder on the equipment. It furnished four compressors, two mechanics for operating the compressors and servicing all of the equipment, and two continuous dry mixers. The compressors had a displacement of 1,800 cu.ft. per minute. The actual free air delivered was measured continuously by means of an orifice in the main air line and a recording differential meter. It was found that the volumetric efficiency of the compressors was approximately 79 per cent. In addition, a city-owned compressor was used, making the total output of the plant 1,630 cu.ft. per minute. This amount of air was sufficient satisfactorily to operate four or five guns with 1¼-in. nozzles, depending on the use of the blow-down line, and five or six small pneumatic hammers for drilling.

Tests and inspection

A simple field laboratory was set up on the job, where daily tests were made to determine the moisture content of the sand as received and as used in the mixers, and the fineness coefficient and silt content of the sand. Continuous

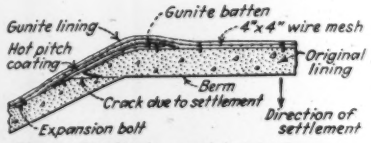


Fig. 1—Detail of expansion joint in gunite relining at angle of slope and berm of Syracuse, N. Y., waterworks reservoir.

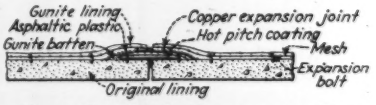


Fig. 2—Detail of bottom expansion joints in Syracuse reservoir, showing copper waterstop.

checks were made to determine the cement ratio in the mix. This was one of the principal routines of the laboratory, as it was found that the mix varied somewhat for a given setting of the mixers, depending on the moisture content of the sand and the manner of feeding the mixers. Daily checks were also run on the moisture content of the gunite shot. By means of these checks the average water content was controlled at each nozzle. This was found to be a highly important feature of the work, as the strength and density of the gunite varied greatly with the water content. Periodic tests were made to determine the moisture content of the rebound, the percentage of rebound and the cement ratio in the gunite. In addition, extensive experiments were conducted on nozzle velocities as a continuation of the study previously conducted at the Westcott Reservoir (*ENR*, Nov. 19, 1931).

Study of nozzle velocity

In connection with the Westcott Reservoir work, it had been found that there is an optimum velocity at which to shoot gunite. Before work was begun

on Woodland Reservoir, all of the guns were equipped by the city with the nozzle-velocity-measuring devices that were developed on the Westcott Reservoir lining job. The velocity at each nozzle was read at the gun by means of a single manometer and a suitably calibrated scale.

A velocity of 375 ft. per second was first used, as previous experimental work had shown this to be the most satisfactory velocity. Most of the previous tests, however, had been made with a ¾-in. nozzle operating with a N-0 gun. As 1¼-in. nozzles and N-1 and N-2 guns were being used on this job, several series of velocity samples were shot to determine the proper velocity to use with this larger equipment. The results of these tests showed that gunite of maximum strength and density was obtained with a velocity of about 425 ft. per second as read on the manometer scale.

After making this determination, opportunity was afforded of checking the manometer velocity scales used in all of the Syracuse work against accurate air-measuring standards, and it was found that these scales were in error, showing air velocities less than actually existed at the nozzle. Correcting for this error, the velocity of 425 ft. per second as read on the manometer scale becomes 510 ft. per second. (These velocities and all of the nozzle velocities mentioned in this article are expressed in terms of the cubic feet of free air per second supplied to the nozzle, divided by the area of the nozzle opening in square feet.)

Fig. 3 shows the average results of the velocity tests on the 1¼-in. nozzle, *corrected* nozzle velocity in feet per second being plotted as abscissas against compressive strength of gunite in pounds per square inch as ordinates. The graph also shows correct nozzle velocities for the average results of all of the velocity tests with the ¾-in. nozzle that were made in connection with the Westcott Reservoir lining and many more recent tests made with the same size nozzle. These velocities are applicable when the nozzle is held at a distance from the work of approximately 4 ft. for the 1¼-in. nozzle and 3 ft. for the ¾-in. nozzle.

Although no tests were made during the work with a 1-in. nozzle, subsequent tests made under actual working conditions with nozzle-velocity meters, where a 1-in. nozzle was used, developed values and results practically in accord with the ¾-in. nozzle, as shown on Fig. 3.

These curves show that a higher velocity is required when using a 1¼-in. nozzle than when using a ¾-in. nozzle. There are many factors which account in part for this, but it is probably due for the most part to the fact that there is a tendency to hold a large nozzle at a greater distance from the work than a small nozzle. In the former case a

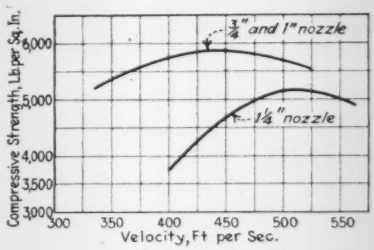


Fig. 3—Graph of compressive strength of gunite placed at various nozzle velocities with three sizes of nozzles, as determined by Syracuse tests.

greater initial speed at the nozzle is required to obtain the same impact for a given particle of sand than in the latter. This is probably due to air friction. Tests showed that holding the nozzle close to the work has the same effect on the quality of the gunite as increasing the nozzle velocity, which means that lower velocities may be safely used on close-up work.

It is probable that the velocity of the sand and cement particles impinging on the surface on which gunite is applied is not that of the air velocity obtained by dividing the air input to the bottom hopper of the gun by the area of the nozzle. The section area of the material and water leaving the nozzle varies with the output of material. Assuming a constant input of air, the nozzle velocity varies, increasing with an increase of material. The sand and cement particles, however, are slowed down between nozzle and work by the friction of the air. Then again the rubber liners of the nozzles wear, reducing the nozzle velocity for a given input of air as the diameter of the liner wears larger. The Syracuse tests were run under normal operating conditions, however, and should be typical and applicable for general use.

The velocities are expressed in terms of air input and of nominal nozzle diameters, as this seems to be the most practical method. On this basis the compressor capacities can easily be calculated for various-sized nozzles, adding 50 to 60 cu.ft. per minute of free air for the air motor on the gun. These velocities are based on free air at 60 deg. temperature at the nozzle.

Fortunately, a relatively large variation in velocity may be used without serious loss of strength and density. As shown by Fig. 3, the velocity, when using 1¼-in. nozzles, may vary from 450 to 550 ft. per second without serious loss of quality. Experience on this work showed that it was neither economical, practical nor desirable to shoot at higher velocities than 550 ft. per second. Velocities below 450 ft. are not recommended except where it is necessary to hold the nozzle close to the work.

Correcting for the error in manometer scale, the recommended operating velocities, as set forth in the previous paper on this subject, would be from 400 to 500 ft. per second for the ¾-in. nozzle. This would also be true for most work with a 1-in. nozzle. However, as both of these small nozzles are used extensively for close work, such as steel incasement, tunnel and sewer work, where it is sometimes necessary to hold the nozzle at about one-half the normal distance from the work, a velocity of 375 ft. per second is more advantageous and does not sacrifice quality on account of the nozzle distance.

As soon as the results of Fig. 3 were available, the average operating velocity was raised from 375 to 425 ft. a second, as shown on the manometer scale, the latter corrected being 510 ft. per second. Throughout the rest of the job a variation in velocity was not allowed of more than plus or minus 6 per cent of this value. As soon as the lower limit was passed, a gun running low was shut down and not put into operation again until the air supply had increased sufficiently to obtain the proper velocity.

This method of measuring and controlling the nozzle velocity was used successfully throughout the job. It was found that uniform velocity made for uniform production and operation of the guns.

The nozzle-velocity meter was also of further value in that it would indicate a tendency of the hose to plug, thereby warning the operator in advance so that he could cut down on his feed wheel in time to avert a complete obstruction. Moreover it was easy to determine which guns were using more air than necessary, whereupon they were throttled, making more air and pressure available for the guns that required it.

Preparing strength specimens

Tests were run at Woodland Reservoir to determine a practical size of gunite specimen that would be large enough to eliminate errors in determining the section area and yet small enough to be easily and readily shot, cut out and broken. The most successful method used throughout most of the job was to shoot a mound of gunite 4 in. thick and about 6 in. square at the base. When this sample had partially hardened, a specimen was cut 4 in. high and 4 in. in diameter. This was done by placing a 4-in. wooden cylinder on top of the specimen and cutting the gunite away with a trowel. The specimen was finally shaved to true cylindrical form by means of a half longitudinal section of a 4-in. steel pipe sharpened to a knife edge and equipped with a handle. The cylinder was used as a guide for the steel pipe shaver. A comparison test indicated that a sample of these proportions would give the same compressive strength as that of a specimen whose height was twice the diameter.

The results, in lb. per sq.in., of the

compressive strength tests on specimens on this work are as follows:

Average of 66 specimens 3 to 5 days old (majority 3 days).....	4,503
Average of 31 cylinders 5 to 14 days old (majority 5 to 7 days)	5,111
Average of 6 cylinders 28 days old.	6,893

These samples were made with the regular sand used in the work, which, while not as hard as obtainable in some sections, was one of the most satisfactory available in the vicinity of Syracuse.

Bulking of sand

The nominal mix was 1 part of cement to 3½ parts of sand measured by volume, sand containing 4 per cent moisture by weight being taken as the standard. Tests showed that the sand used bulked to the maximum when containing from 3 to 4 per cent moisture. With this moisture content the bulking action gave the sand 26.5 per cent more volume than in a bone-dry state. The amount of sand used in gunite was 6,430 cu.yd. This was measured in a semi-compacted state in the truck bodies as they arrived on the work. The moisture content averaged about 6 per cent. It was found that the sand bulked about 8 per cent from the truck to the storage pile, and that further bulking of 10 per cent occurred when the sand was dried out to contain about 4 per cent moisture. The total sand used on the basis of 4 per cent moisture was therefore 7,570 cu.yd. As the total number of bags of cement used for guniting was 53,718, the average mix was therefore about 1:3.8.

Confirming previous experience at Westcott Reservoir, it was found that sand containing 4 per cent moisture by weight was ideal for the best operation of the mixers and guns. This degree of wetness gave maximum production and uniform application of the gunite.

For this reason and for the reason that the mix was based on sand containing this moisture content, an effort was made to reduce the moisture content of the sand as received to this value before reaching the mixer. While it was not practicable to obtain this ideal at all times, the storing of sand in shallow piles and the manipulation that it received in transporting it from the storage pile to the mixers on a belt conveyor generally accomplished the desired result.

Determining cement ratio

The method used to determine the amount of cement in the dry mix and also in the gunite was to dehydrate a sample with a centrifuge and burning alcohol, and to sieve the material, obtaining the per cent of the sample by weight which passed a 200 sieve. By referring to a curve that was empirically established at the beginning of the job the amount of cement in the sample of mix was easily determined. Data for this curve (Fig. 4) were obtained by making up sample mixes of various ratios of cement to sand, the latter containing 4 per cent moisture by weight and sieving the samples. The amount passing the 200-sieve was directly proportional to the cement content. The per cent of the samples by weight passing the sieve are plotted as abscissae against mix ratios as ordinates.

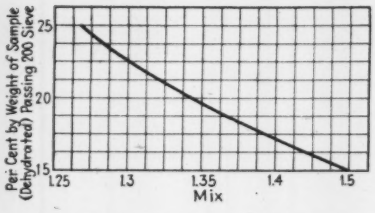


Fig. 4—Ratio of cement to sand in gunite of various proportions, with 4 per cent water content in the sand.

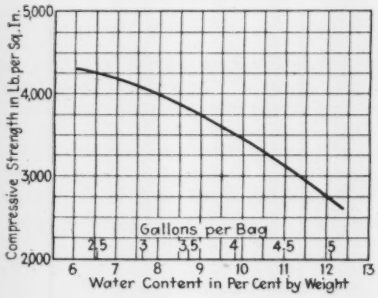


Fig. 5—Relation of strength to water content of gunite mixtures.

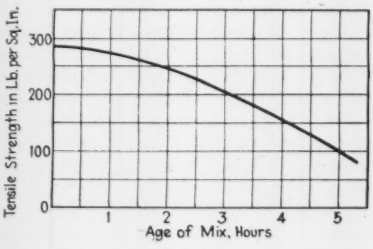


Fig. 6—Strength of gunite as affected by age of dry mix.

Water content

The water content of the gunite was determined by dehydrating a sample of gunite with a centrifuge and alcohol. This was done as soon as it was shot, and the moisture content was expressed in terms of the total weight of the sample before dehydrating. To determine the water content to be used to obtain maximum strength and density, samples of gunite were shot at various moisture contents, and these samples were tested for compressive strength.

Fig. 5 plotted from data obtained by this test shows that the strength increases as the water content decreases. Water content is shown in per cent by weight of the sample and also in gallons per sack of cement. The latter values have been computed, the unit weight of the sand and cement used being known. A 10 per cent moisture content by weight is calculated to be a little over 4 gal. per sack. In the previous article (*ENR*, Nov. 19, 1931) the top of the strength curve corresponded to about 6 gal. per sack. This water content, however, was expressed in terms of the total amount of water used in shooting the gunite, including the moisture content of the sand and the water added at the nozzle. There is a loss of water in the rebound and a considerable loss in atomization. The latter has been found by test to be as high as 1 to 2 gal. per sack.

There was found to be a practical limit to the dryness at which the gunite could be shot. When shot with a moisture content of 8 per cent or less, it was difficult to incase properly the mesh in the gunite without entrapping rebound behind the wires. Experience showed that a 10 per cent moisture content was practical for the gunite under the mesh and 9 per cent for gunite above the mesh. This practice insured a good quality of gunite below the mesh and a denser harder layer above it.

At the beginning of the work, before the men were trained to this relatively dry shooting, gunite was shot somewhat wetter, probably averaging a moisture content of 11 per cent. At the completion of the job it was noted that the gunite that was shot with this moisture content had developed many more hair cracks than occurred in the gunite that was shot with less water. Moreover, the dryer gunite appeared to be of better quality, having a hard dense surface.

Gunite shot with a moisture content of 9 to 10 per cent is relatively dry. In shooting with this moisture content it is necessary to exercise great care to avoid rebound pockets and laminations. The question may be raised as to whether it is economically practicable to shoot with this low moisture content on account of the increase in rebound. If maximum density and strength is not required, it is doubtful if this degree of dryness is necessary. However, for reservoir linings, where the gunite is subjected to extreme ranges of temperature before and at the time of filling the reservoir, and where density and watertightness are of prime importance, experience at Woodland Reservoir would seem to justify the additional cost for sand and the labor of removing the rebound.

It does not follow that the most satisfactory water content on this work, expressed in per cent of a given sample of gunite, will be applicable on other work, as this ratio varies somewhat, depending on the characteristics of the sand and on the mix. It is comparatively easy to obtain these data for a given sand and mix. Once the most satisfactory water content is established on a job, uniform water content of the

gunite can be maintained by frequent tests and careful observation.

Age of dry mix

During the early part of the work it was the custom to provide a storage of mixed material in the bin above the guns which would last from two to three hours in the event of a breakdown in the mixing plant. Some of the material in the bin that was mixed early in the morning might not be used until nearly noon, as it was the practice to empty the bin completely every four hours. Laboratory tests indicated that this mix produced gunite of poorer quality than did a fresh mix. Further to study this condition, mortar briquettes were made up at hour intervals after the initial dry-mixing of the ingredients, and the briquettes were tested for tensile strength. The briquettes showed a substantial loss of strength for every hour that elapsed after the mixing of the sand and cement (Fig. 6). From the time that these tests were made it was therefore the practice to provide storage of not over an hour's supply and to keep the mix in the bin above the guns thoroughly stirred up so that no dead areas occurred.

Another special test made was to run sand through a gun under normal operating conditions and to measure the percentage of this sand passing a 200-sieve. The amount of sand passing the sieve was found to be about 7 per cent greater than existed in the sand before shooting, showing that the gun has a considerable pulverizing effect on the soft particles of the sand. This emphasizes the need for a hard sand for gunite work, free from shale and other sofe particles.

Strength

The unit strength of gunite, as shown on the accompanying curves, is the strength that was obtained for the particular tests which they illustrate and does not necessarily represent the strengths of gunite that can be obtained under favorable shooting conditions and with the best quality of materials.

The mix, of course, has a direct bearing on the strength. A series of seven-day specimens shot to study the effect of mix on strength showed a variation of from 4,000 lb. per sq.in. for a mix of 1:6 to more than 7,000 lb. per sq.in. for a mix of 1:3. Other specimens have been tested by the writer. These were made with a particularly hard sand and a mix of 1:3½, which tested from 7,000 lb. per sq.in. to nearly 10,000 lb. per sq.in. at an age of 6½ days.

Attention is called to Fig. 5, showing the relation of water content to compressive strength. The strengths obtained in this test were relatively low and do not truly represent the average strength obtained on the job. This is accounted for in part by the fact that the specimens were broken three days after they were made, whereas nearly all of the specimens broken in connection with the experimental work were seven days old. The relationship of water content to strength, however, is typical and agrees substantially, as far as this relationship is concerned, with the data developed on the Westcott Reservoir project.

Conclusions

The following conclusions may be drawn as a result of observations in reservoir-lining work at Syracuse.

Experience at Woodland Reservoir showed that to control the various phases of shooting gunite is not only desirable from an engineering point of view but is also practicable and an advantage to operation and production.

To measure and to regulate nozzle velocities insures a more uniform strength and density than could possibly be obtained by specifying a pressure under which the gun is to operate. The latter depends on many operating conditions and is not a measure of nozzle velocity. Nozzle-velocity meters provide a ready means of observing whether the flow of material through the hose is uniform, indicating at once any tendency to clog. The gunman may avert many shut-downs by slowing down the feed wheel until the obstruction has blown clear. This feature increases production. Then again, it appears that while insufficient velocity reduces the strength and density of the gunite, excessive velocity is also detrimental to the gunite in the same manner and increases the amount of rebound. Regulation can be readily controlled when the cement gun is equipped with a nozzle velocity meter.

The value of the control of the water content in concrete work has been conclusively demonstrated in recent years. The experimental work to date would indicate that the same is true of gunite. Not only is strength and density sacrificed when excessive water is used, but the results at Woodland Reservoir showed that hair cracks at the surface of the gunite are much more prevalent when the gunite is shot relatively wet than when dry.

Controlling the moisture content of the sand at the mixer makes for smoothness of operation and maximum production. From 4 to 5 per cent moisture content by weight has given the best results on the work at Syracuse.

The sand should be well and uniformly graded. A hard sand is especially desirable for gunite work, as soft particles are pulverized, forming a dust that may form a film on the harder particles, thereby weakening the bonding action of the cement. The age of the mix is another factor to be considered in obtaining the best gunite. As soon as the cement comes in contact with the moist sand, hydration begins. The result is that the effectiveness of the cement is lost as the mix ages. The storage of mixed materials should therefore be kept at a minimum, and no inactive spots should be allowed to occur in storage bins.

The cement ratio in the mix should be kept constant for uniform gunite. With a change in moisture content in the sand, the per cent of bulking changes, requiring a modification of the mix to maintain a constant cement ratio. If continuous mixers are used, the method of feeding the hoppers should be uniform in order to maintain a constant ratio of cement to sand.

The importance of special care to secure good laps cannot be stressed too strongly, especially for watertight linings. Clean surfaces free from rebound are essential for a watertight bond.

Records of Groundwater Supplies in Texas

INVESTIGATION of the groundwater resources of Texas by the United States Geological Survey and Texas Board of Water Engineers, made for the most part since September, 1929, has covered thus far all or parts of about 30 counties. The Engineering Experiment Station of the Texas Agricultural and Mechanical College is cooperating in this work, and the State Board of Health has cooperated in making studies of the sanitary condition of the groundwater in several counties. Thus far six mimeographed reports giving some of the results of these investigations have been issued and distributed to the public. Eventually reports covering the work are to be published by the Survey as water-supply papers.

In connection with these investigations records have been obtained of more than 3,000 wells. In large numbers of the wells the records include size of well and total depth, depth to the water level, depth to the top of the principal water-bearing bed and thickness and character of the bed, method of lift, kind and amount of power used, kind of pump used, and yield of well from natural flow or under pump in gallons a minute. The records are being assembled and tabulated, and as fast as this is done copies of the tables are filed in the main office of the Geological Survey, Washington, D. C., and in the office of the Texas Board of Water Engineers, at Austin, where they may be consulted by the public. The counties for which well records have thus far been released to the public by this method are Dimmit, Zavala, Uvalde, Medina, Frio, Atascosa, Maverick, Gregg, Rusk, Nueces, and San Patricio. With the records for Nueces and San Patricio counties a brief interpretative memorandum has been released.

New Cement Specifications Proposed in France

Single specification covers nine groups or types, with a total of 36 grades from hydraulic lime to high-alumina cement

THE dissatisfaction of many American engineers with the single-standard portland cement lends special interest to a new specification proposed by the French standardizing body, L'Association Française de Normalisation, which is under discussion for possible early adoption. It covers in a single document and under one set of test methods the full range of hydraulic cements current in France, embracing nine different groups or types with a total of 36 grades.

Consideration of this wide range of hydraulic cementing materials tends to support the growing belief that a particular cement is not necessarily best adapted to different service conditions, and that proper conservatism need not interfere with new developments in materials. As is well known, however, foreign practice is not directly applicable to American conditions, and the remarkable list of French cement types and grades is therefore to be read with caution and interpreted mainly as evidence that the French cement user has learned where and how to use the 36 grades to fit various service demands.

The following, abstrated from the August *Revue des Matériaux de Construction et de Travaux Publics*, indicates briefly what these different groups and grades of French cements are. The strength requirements are given by the numbers that appear after each grade. Where three sets of numerals are given, the first indicates the strength at 48 hours, the second at 7 days, the third at 28 days. Where two sets appear, they represent the strength at 7 and 28 days. All values are in lb. per sq.in. approximate equivalent of the metric values. The test specimen is a 5-cm. cube made of a 1:3 by weight graded sand-mortar, the consistency of which appears to be about that of our standard consistency.

Group 1 — Hydraulic Limes (Chaux Hydrauliques). Hydraulic limes result from burning more or less argillaceous limestone and reducing the product to a powder through slaking (or slaking and grinding) with or without the addition of ground grappiers, those parts of burned argillaceous limestone which resist slaking. Two classes, each with two to three grades, are distinguished:

Class A—Hydraulic limes as defined above.
Grade 1—Hydraulic, 70-180.
Grade 2—Strongly hydraulic, 180-355.
Grade 3—Strongly hydraulic for special purposes, 450-900.

Class B—Hydraulic lime-slag blends (*chaux au laiter*). This class is composed of those hydraulic lime-slag mixtures containing less than 30 per cent of ground quenched basic blast-furnace slag.
Grade 1—Standard, 180-355.
Grade 2—Special, 450-900.

Group 2—Slag Cements (Ciments de Laitier). The slag cements result from prepared mixtures, perfectly homogeneous and finely ground, or granulated quenched basic blast-furnace slag with either—

Class A—Not more than 30 per cent of slaked or hydraulic lime, or
Class B—Not more than 15 per cent of portland cement.

There are two grades in both classes:
Grade 1—Standard, 710-1420.
Grade 2—Special, 1420-2275.

Group 3—Natural Cements (Ciments Naturels). Natural cements result from the grinding of burned natural mixtures of argillaceous limestones of uniform composition.

Class A—Rapid-setting.
Grade 1—Ordinary, 180-285-450.
Grade 2—Standard, 285-450-710.
Grade 3—Special, 450-710-1140.
Class B—Slow-setting.
Grade 1—Ordinary, 180-355.
Grade 2—Standard, 355-710.
Grade 3—Special, 710-1420.

Group 4—Grappier Cements (Ciments de Grappiers). Grappier cements are produced by the grinding of the "grappiers" produced in the manufacture of well-burned limes.

Class A—Grappier cements.
Grade 1—Ordinary, 180-355.
Grade 2—Standard, 355-710.
Grade 3—Special, 710-1420.

Group 5—Portland Cements (Ciments Artificiels). Portland cements are obtained from mixtures composed principally of carbonated lime, silica, alumina and oxide of iron carefully proportioned, chemically and physically homogeneous, burned almost to fusion and then ground to a powder. (Agreement has not been reached on the amount of additions subsequent to burning for regulating the set and other properties. There is agreement that the maximum SO_3 should not exceed 3 per cent. There is a possibility that other additions than sulphates may be allowed.)

Class A—Portland cement.
Grade 1—Standard, 1420-2275.
Grade 2—Special, 2275-3550.
Class B—High-early-strength cements.
Grade 1—Ordinary, 1420-3550-4500.
Grade 2—Special, 2275-4500-5700.

Group 6—Blended Cements (Ciments Composés). Blended cements are produced from carefully controlled homogeneous mixtures, finely ground, either of any of the several varieties of hydraulic cements or of hydraulic cements and chemically inert materials, or natural minerals.

Class A—Mixed cements (*oiments mixtes*). Mixed cements are mixtures of grappiers and natural or portland cements.

Class B—Diluted cements (*ciments am... gris*) are mixtures of portla... cement and inert minera... There are 3 grades in each ... these classes.
Grade 1—Ordinary, 180-355.
Grade 2—Standard, 355-710.
Grade 3—Special, 710-1420.

Class C—Pozzuolanic cements (*cimen... aux pouzzolanes*) are mixtur... of hydraulic cement and po... zuolana other than blast fu... nace slag.
Grade 1—Standard, 1150-2275.

Group 7 — Portland Cement-Sla... Blends (Ciments Métallurgiques). Th... portland-slag cements are produced b... mixing and fine-grinding carefully pre... pared mixtures of portland cement an... basic granulated water-quenched blast... furnace slag.

Class A—High portland-low slag mixture... (*ciments de fer*) are mixture... of portland cement and slag i... which the slag is between 1... and 30 per cent.

Class B—Low portland-high slag mix... tures (*ciments de haut four... neau*) are mixtures of slag and... portland cement in which th... per cent of slag is between 30... and 85. There are two grades... in each of these classes of... cement.
Grade 1—Standard, 1420-2275.
Grade 2—Special, 2275-3550.

Group 8—High-Sulphate Slag Cements (Ciments Métallurgiques Sursulfatés) are produced by adding to basic granulated water-quenched blast-furnace slag small quantities of portland cement or slaked lime and sulphates in such quantities that the per cent of SO_3 shall exceed 5. There are two grades in this group.

Grade 1—Standard, 1420-2275.
Grade 2—High-early-strength, 1420-3550-4500.

Group 9 — High-Alumina Cements (Ciments Alumineux) are produced by grinding, after heating to or almost to fusion, mixtures composed principally of alumina, silica, oxide of iron, and lime or carbonate of lime. They should contain at least 30 per cent oxide of alumina. There is but one grade in this group of cements, with 48-hour, 7-day and 28-day strengths of 4,500, 5,000 and 5,700 lb. per sq.in.

Dampness on Masonry Walls

A letter circular (LC-391) has been prepared by the Bureau of Standards, which enumerates the causes of dampness on the interior surfaces of masonry walls above grade. The conditions favorable to condensation on masonry walls are described. Inadequate protection of masonry from water collected on roofs or other horizontal or sloping surfaces is cited as a frequent cause of dampness. Relations between rainfall, wind velocities and absorptive properties of masonry walls are found to indicate that occasional dampness should be expected when plaster is applied directly to the interior surface of ordinary walls 8 in. thick. Different types of colorless waterproofings are compared and methods for treating masonry are discussed. Specific methods are given for remedying dampness in masonry walls.

Santa Fe Elevates Its Tracks in Oklahoma City

For 2½ miles, through principal business section of the city, a fill between retaining walls supports the railroad roadbed above the streets, thirteen of which pass through in subways

By H. W. Wagner
Chief Engineer, Eastern Lines, Atchison, Topeka & Santa Fe Ry. Co., Topeka, Kan.

ELEVATION of the tracks of the A.T.&S.F. Railway Co. through Oklahoma City, Okla., was begun in 1931 as part of an extensive program of railroad readjustment demanded by the growth of the city. The first step in this program consisted of the abandonment by the C.R.I.&P. Railway Co. of one-half mile of its main track through the business district of the city and the construction of approximately 7

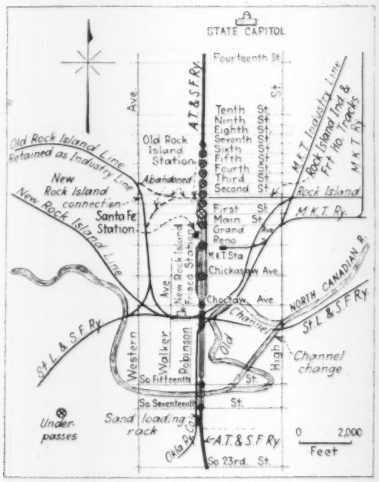


Fig. 1—The 2½-mile track elevation of the Santa Fe in Oklahoma City cuts directly tthrough the main business district from north to south. Thirteen grade-separations with streets and three with railways are included, as well as a new bridge over the North Canadian River.

miles of new line to reach a location on the southern edge of the present business district adjoining the tracks of the St.L.-S.F. Railway Co., where a new passenger depot for the joint use of those two railroads was constructed (*ENR*, March 24, 1932, p. 432).

With the removal of the Rock Island tracks where they had crossed the line of the A.T.&S.F. Railway Co. between First and Second Sts., the way was opened for the second step in the program, requiring the elevation of the Santa Fe tracks through the business section of the city for a distance of about 2½ miles, from Ninth St. on the north to South 23d St., south of the North Canadian River.

As indicated in Fig. 1, this elevation provides subways at thirteen street crossings and at the crossings of the Rock Island, Frisco and Oklahoma Belt Railways, thereby completely eliminating interference between Santa Fe and other traffic, both street and railway, with the exception of street traffic over a few team and other side tracks necessarily remaining at grade from First St. south. Elevation of tracks is such as to give 14 ft. clear headroom at street crossings and 22 ft. at the Frisco Railway. The filling material, consisting of sand pumped from the river bottom, is confined between reinforced-concrete retaining walls of the cantilever type throughout the north half of the elevation. South of Choctaw Ave. the fill is allowed to take its natural slope.

Included in the plan is a new bridge over the North Canadian River, rearrangement of team and freight-house tracks and a new passenger station on the site of the present depot building. With the exception of the depot, the project is practically complete and in service.

Grading

Contract for the grading, called for approximately 650,000 cu.yd. of embankment, about two-thirds of which was required through the river bottom, where a fill with a maximum height of about 38 ft. forms approaches each side of the new river bridge. This fill from the south end of the elevation to a point north of the Choctaw Ave. subway was built first, being pumped directly into place by a floating dredge, which was engaged, under a separate contract with the city, in straightening the river channel east of the new bridge.

From Choctaw Ave. north to the end of the elevation at Ninth St., the pumped sand fill is confined between retaining walls. For a short distance at the south end dikes were maintained inside the walls as a measure of protection against excessive pressure. Sand was pumped directly into the fill up to a maximum distance of about 4,000 ft. North of this limit, filling material was hauled by work train in 30-yd. air-dump cars. For loading these cars the mixture of sand and water was pumped by the dredge to an elevated steel cylinder 45 in. in diameter and 200 ft. long placed between two loading tracks (Fig. 3). Gates provided in the bottom of this cylinder opened into swinging steel spouts through which the sand was discharged into cars on either track. A vented pipe at the end of the cylinder opposite the inlet permitted the escape of excess water.

Retaining walls

For constructing the retaining walls and the subways, the contractor installed a central batching plant with facilities for handling bulk cement, and provided three-batch trucks for hauling materials from the batching plant to paving mixers equipped with towers for elevating the concrete to the top of the forms. The retaining walls are of cantilever type. Spread footings are used where conditions permit; but north of First St., where the retaining walls are necessarily located close to industrial buildings on private property adjoining the railroad right-of-way,

Fig. 2—The elevated structure consists of a sand fill between concrete retaining walls. Some team and industry tracks remain at grade, while others are placed on the fill at the second-story levels.

Fig. 3—Air-dump cars being loaded with river-dredged sand. These cars placed the fill in that portion of the project over 4,000 ft. from the river. Nearer the river sand was pumped directly into place.

foundations consist of cast-in-place reinforced-concrete cylinders extending to rock. The backs of all retaining walls were given two coats of an approved damp-proofing compound, and in addition weep holes and tile drains connecting to storm sewers were provided.

Subways

Subways consist of gravity-type concrete abutments and reinforced-concrete column bents at the curb lines and the center of the streets, supporting concrete-incased steel beam spans. (Some details of these structures are shown in *ENR*, March 24, 1932, pp. 434 and 435). The backs of all abutments were given two coats of damp-proofing the same as the retaining walls, while the decks were covered with a three-ply felt-and-cotton fabric waterproofing, protected by 1-in. asphalt plank. Steel pipe railings with cast-iron posts are continuous along the retaining walls and across the subways.

Overhead clearance at the street subways varies from 14 to 14½ ft., clear widths of sidewalk openings from 4 ft. to 10 ft. 9 in., and clear roadway widths from 20 ft. to 47 ft. 9 in. Three of the less important streets have a single roadway opening, while the remainder have double roadways, with column bents at the center of the street and at curb lines.

Subways for the Rock Island and Frisco Railways provide room for two tracks passing under four Santa Fe tracks in both cases, and are of the same type as the street subways, with the addition of cast-iron blast plates to protect the bottom of the concrete incasement and the lower flanges of the beams. Overhead clearances at these railways are 21 ft. 8 in. and 22 ft., and minimum side clearances are 8½ and 10 ft. The single track of the Oklahoma Railway Co., whose traffic consists entirely of switching movements, is carried under the Santa Fe tracks through a reinforced-concrete box.

River bridge

The new bridge over the North Canadian River consists of seven 106-ft. double-track deck-girder spans on eight concrete piers, each pier resting on two concrete cylinders 16 ft. in diameter carried well into solid rock by dredging through open caissons. At the south end, an additional 50 ft. deck-girder span provides an underpass for South 17th St., and at both ends there are short ballasted-deck pile-trestle approaches.

Construction program

The new bridge was built just east of the old truss span and its trestle approach, the layout of new tracks being planned so that this could be done and so that the east ends of the Oklahoma Railway Co.'s box and the Frisco, Rock Island and Choctaw Ave. suways could be built and sufficient fill placed to carry one elevated track without interfering with traffic on the old main track. When this elevated track wa ready for use, traffic was diverted t it, the old main track removed and th west side of the high fill and west end of the box and subways placed.

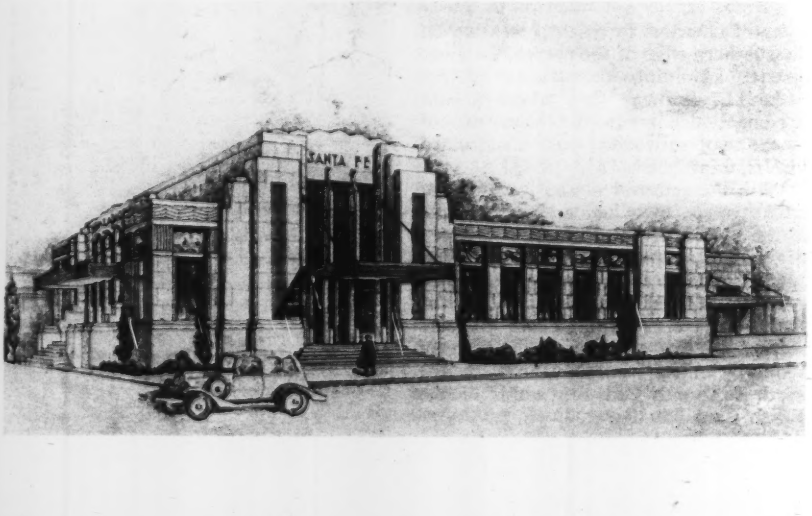
Temporary facilities for handlin mail, express and passenger busines were established on the east side of th station grounds south of Grand Ave at street grade. This permitted the con struction of the west retaining wall an the west ends of the subways from Chickasaw Ave. to Sixth St. inclusive and the placing of filling material along this wall, so that one elevated track could be built while freight and passenger traffic was being handled at street grade on the east side of the right-of-way. Upon the completion o this elevated track, traffic was turned over it, the east retaining wall and east ends of the street subways were built, and the filling between walls was completed. Placing of the embankment along the west wall between streets was accomplished without the use of a temporary trestle by dumping filling material from a track at street grade and handling it into place against the wall with a clamshell bucket crane.

Depot building

A new passenger depot building is planned, to be located on the same site as the present station. An extension of the concourse under the elevated tracks forms a passenger subway from which stairs lead up in each direction to the platforms. Two of these platforms, each 21 ft. wide, are served by four passenger train tracks. Platforms are covered by steel-frame train sheds with wood sheathing and built-up asphalt roofing.

Baggage, mail and express rooms are located in the south end of the building, extending partly under the raised tracks, with two elevators for handling trucks between the street level and the platforms at elevated track grade. No work has been done as yet on the construction of the passenger depot proper, though

Fig. 4—Architectural rendering of the proposed station building in Oklahoma City.



the baggage, mail and express rooms and elevators have been completed and placed in service. Pending the completion of permanent facilities, arrangements have been made for temporary waiting rooms and a ticket office in a part of the space designed for the handling of baggage, mail and express.

The present freight depot, located a short distance south of the new passenger station, has been remodeled to provide space for a boiler plant to heat the freight and passenger depots and provide steam for heating Pullman or other layover equipment.

A brick building on the elevated track level at the south end of the passenger platforms is provided for the use of car inspectors, cleaners and Pullman employees; it provides necessary lavatory and locker rooms, supply storage rooms and battery-charging facilities.

North of Main St. on the west side and of Second St. on the east side, all tracks, including industry tracks, were elevated. This required some rearrangement on the part of industries to enable them to handle their shipments at the second-story level, and in one case called for steel trucking bridges from the elevated tracks to the factory. The complete elimination of all railroad traffic at street grade in this part of the city, however, was considered sufficiently desirable to justify the expense.

Except in the case of the Rock Island, connecting tracks for the interchange of cars with other railroads presented no particular difficulty, although in one case limited space necessitated a grade of 2.5 per cent. To secure a convenient connection for interchange with the Rock Island, it will be necessary to cross Second St., requiring a single-track bridge together with a considerable length of trestle or retaining wall to avoid interference with existing improvements.

This work has been carried out under the direction of the writer, with H. L. Hunter in direct charge of the work. The station was designed by E. A. Harrison, Santa Fe architect, and the subway spans by R. A. Van Ness, Santa Fe bridge engineer. Leo Sanders, Oklahoma City, held the contract for the grading work, and the T. A. Allen Construction Co., Los Angeles, the contract for the concrete retaining walls and the subways.

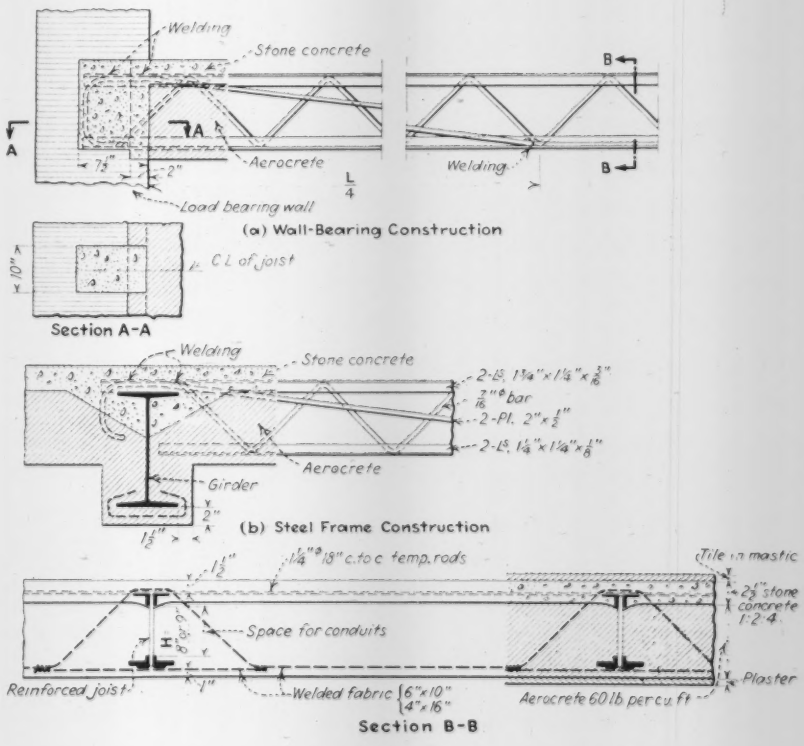
Unique Floor Slab Uses Two Kinds of Concrete

Long-span, light-weight construction in new Pine Plains, N. Y., school consists of a slab of expanded cellular concrete topped with stone concrete and utilizing special bar joists for reinforcing

A NEW TYPE of light-weight floor construction for long-span flat-ceiling requirements was utilized for the first time in the recently completed Central School at Pine Plains, N. Y. The construction consists of a slab of an expanded light-weight cellular concrete (Aerocrete) in which tensile steel is embedded near the bottom and on top of which is placed a layer of stone concrete to take the compression. As a practical construction expedient the steel is in the form of reinforced bar joists which serve to support the dead load of floor and forms until the concrete has set. The joists used vary somewhat from the usual standard designs in that their chords are of slightly greater area, the bottom chord of two angles being reinforced with two 2x½-in. steel strips. These flats are tack-welded on top of the outstanding legs of the bottom chord over the center half of the span, bent up at the quarter points, welded to the under side of the top-chord angles and hooked on the end. This hook is carried down to a welded connection with the bottom-chord angles, which form the bearing seat for the trusses on the brick walls of the school. (In steel-frame structures the hook would merely engage the upper flange of the floor beam, so that the tops of the joists and floor beams would be practically the same elevation, as shown in Fig. 1b.) Shallow depth, long spans, flat ceilings, wide truss spacing, first-class fireproofing qualities, light weight and sound resistance (due to the special cellular concrete) and rapid construction are among the advantages claimed for this new floor design.

Stress analysis and proportioning in a slab of this type differ from a conventional slab only in the algebra of the flexure formulas used. These formulas include new factors because the compression area is concentrated in the stone concrete and does not extend to the neutral axis of the section, as is usual. Fig. 2 gives these formulas. The factor q is the ratio of the thickness of

Fig. 1—Typical details of long-span composite floor as used in Pine Plains school and as proposed for use in steel-frame buildings.



the stone concrete to the total depth *d* of the section.

In the Pine Plains school the spans were 22 ft. 3 in. and 24 ft. 6 in. For the shorter spans, 8-in. bar joists of the type shown in Fig. 1a were used, spaced up to 4 ft. 2 in. centers, giving a 10½-in. floor thickness. The longer spans required 9-in. joists on 3 ft. 9-in. centers, resulting in a 11½-in.-thick floor. After the joists were set and light transverse bridging placed, forms were suspended by wire clips from the truss bottom chords. The light-weight concrete was then poured to such a depth that, after expanding, it was about ½ in. below the top chord. The amount of this expansion is determined by the relative proportion of the Aerocrete compound in the mix. Expansion required about 45 min. After the material had set for two days a 2- to 2½-in. topping of 1:2:4 stone concrete was poured, incasing the top chords of the joists and at the ends being carried down to a bearing on the walls.

Laboratory tests

Before approving this type of construction for the Pine Plains school, the architects and the engineer asked that a load test be made. Accordingly, a panel

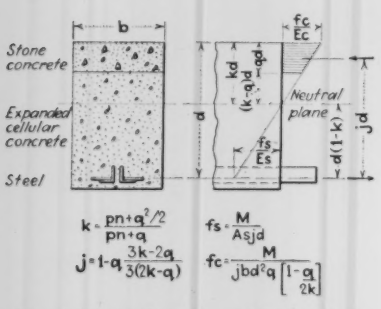


Fig. 2—Flexure formulas used in designing the composite floor slab. Difference from conventional formulas results from difference in compression area, which extends only to depth of stone concrete instead of to the neutral axis.

was constructed, supported at the end by brick piers spaced 22 ft. 3 in. apart. Three 8-in. reinforced bar joists, spaced 4 ft. on centers, supported the slab, which had a total width of 9 ft., a depth of 10½ in. and was designed for a live load of 60 lb. per sq.ft. Arrangements were made to have the design of the slab meet the requirements of the building department of New York City, so that approval for its use in the city might also be obtained. As a consequence, all welded members had to be cut, since welding is not permitted under the present New York building code. Inasmuch as the slab had already been built when this decision was made, it was necessary to drill and saw into the slab at the edges and bottom in order to flame-cut all the diagonal members and the welds that joined the flat bars to the chords. The holes that were caused by these cuts were then filled in with plaster of paris.

In the tests the slab was loaded in increments of 100 lb. per sq.ft. Failure occurred at an applied load of 66,200 lb., or 331 lb. per sq.ft. The applied load for the maximum allowed load (when the deflection was 1/360th of the span) was 200 lb. per sq.ft., about 3½ times the design load of 60 lb. The failure of the slab developed from the cuts in the top slab, whose shear value had been reduced at these points. Both the piers tilted and were badly cracked. Further tests to verify bond and shear stresses in the combined section were made and supervised by Weiskopf & Pickworth, consulting engineers, New York. With the completion of these tests, approval for this design was granted by the New York City building department as well as by the architects and engineers of the Pine Plains school.

Field tests

After the school was completed, a section of floor 8 ft. long in a direction at right angles to the joists was loaded at the center of the 22 ft. 3-in. span with 4 tons of dead load, representing the equivalent of 90 lb. per sq.ft. uniformly distributed. This load produced a deflection of about 1/32 in., which disappeared when the loading was removed from the floor; the allowable deflection for plaster ceilings of this span is about ¾ in.

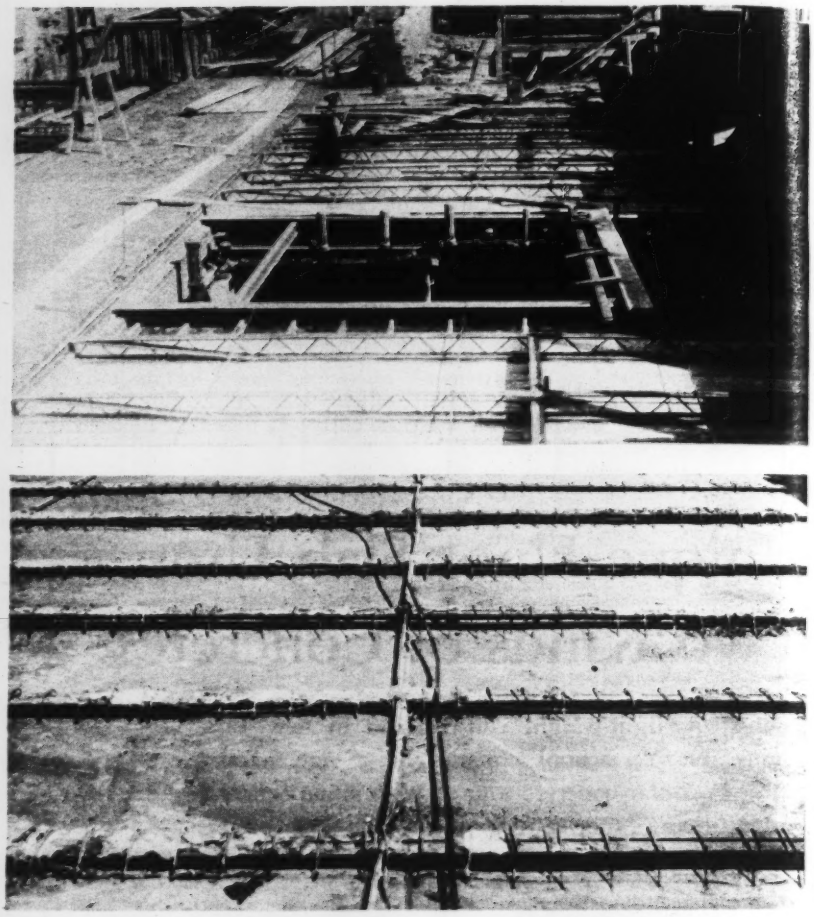


Fig. 3—Composite floor of Pine Plain school under construction. Upper view shows bar trusses and forms in place. In lower view lightweight slab is ready for stone concrete topping.

For the Pine Plains school, Knappe & Morris, New York, were the architects, and Matthew J. Hiller, Jr., New York, was the engineer. Origination of this unique floor design is credited to Rolf Sahlberg, chief engineer, The Aerocrete Corporation of America, New York.

Paving for the Mersey Tunnel

Cast-iron blocks are to be used for the paving of the vehicle tunnel under the Mersey River between Liverpool and Birkenhead, England. The blocks are 1 ft. square, with diamond-shaped non-skid studs on the wearing surface, which have been hardened by a patented process. In all, about 50,000 sq.yd. of this pavement are to be used in the tunnel and on the approach driveways. The cast-iron paving is made by the Stanton Ironworks Co., Ltd., Nottingham, England.

Are Low-Cost Bituminous Roads Really Economical?

A word of caution relative to the choice of materials to fit the particular need and of methods of handling to get the best results

By Hugh W. Skidmore
Consulting Engineer; President, Chicago Paving Laboratory, Chicago, Ill.

CERTAIN fundamental principles that must not be overlooked underlie all forms of bituminous surfaces. Adequate stability against traffic forces is a basic consideration, aside form another important one—resistance to weathering. The two are inseparable in so far as they are both dependent on the bituminous binder for the latter property. This article is a plea for better results through better control of methods and material.

During recent years vast mileages of so-called low-cost highway surfaces have been constructed. To a considerable extent these have been experimental, mainly due to the fact that highway engineers responsible for them have not been thoroughly familiar with the limitations as well as the possibilities of bituminous materials in their almost innumerable forms. The cry, "Low-cost bituminous roads for real economy!" has swept the country. Producers and sellers of bituminous materials have been responsible in a large measure for many mediocre jobs and failures simply because greed and human nature have prevailed over actual knowledge of possible results, or lack of caution in recommending materials as "sure-fire" when results were in doubt.

Low-cost bituminous roads are really economical only when properly built. Federal, state and local road engineers as a whole know a great deal more about this job now than they did five years ago. But many of their projects have resulted in failures which could readily have been avoided. Failures always cost somebody money; in the case of public works they cost everybody money.

The more knowledge that highway engineers glean by actual experience, the more they come to realize and practice the fundamentals long ago established in hot-mix bituminous procedure. Yet for the most part these engineers refused to consider these well-established engineering principles in the early stages of the development of road-mix, retread, cold-mix and various other modifications of the generic type. They laughed at the hot-mix technologists and said: "You don't know anything about this new game of mixed-in-place construction." But, strange to say, in this very brief time they have come, or are rapidly coming, to controlled aggregate gradings and controlled properties of bituminous binders for very specific uses and aggregate characteristics. In brief, they are adopting hot-mix technological practices just as rapidly as their failures point the way.

Sources of stability

There are three sources from which bituminous paving compositions may derive stability against traffic forces. One is by way of the mineral aggregate, another is by way of the bituminous binder, and the third and most sound way is by means of an intelligent combination of the other two. Hot-mix men knew this many years ago. Cold-mix and road-mix enthusiasts are now evidencing real signs of awakening knowledge of incontrovertible facts surrounding the by-no-means simple science of building lasting and serviceable bituminous highways.

One cannot go out and coat any old aggregate, coarse or fine, with any black and reasonably sticky liquid substance and expect to obtain a road. It is mainly the result of luck rather than good sense and real knowledge that many bituminous roads built in recent years are still giving service.

As stated, the mineral aggregate is one source of stability and an important one. Witness how quickly many states came to a graded mineral containing a goodly proportion of very fine filler element. An open, all-coarse aggregate will develop and retain a certain amount of stability so long as the bituminous film adheres in somewhere near proper thickness, but the limitations in this direction are quite narrow, and, regardless of the quality of the bitumen, these limits cannot be safely exceeded. Likewise the binder has certain definite stabilizing properties depending upon its source, method of refining and degree of permanent liquidity, which may not be exceeded when depending upon these alone.

An intelligent combination of these two flexible elements can be scientifically so utilized as to meet any kind of traffic in any climate, and with almost any available aggregate, and may do so successfully at low cost.

Examples of poor practice

Perhaps as fair a manner as any of beginning a brief discussion of some of the important features of successful low-cost bituminous construction is by way of reference to a few examples of definitely poor practice. One state, after several years of rather extensive bituminous construction, is still using a relatively low viscosity oil for coating coarse gravel, devoid of fines, in blade-mix on an extensive program of surfacing designed to eliminate the heavy expense of frequent applications of dust-palliative oil. This idea is commendably sound, but the binder used in this road-mix work is causing much concern because, to the experienced man, it is obviously too light. Two methods of correcting this trouble are open. One is the addition of fines, including a fair proportion of material passing 200-mesh, and the other is the use of a heavier binder that will prove much cheaper than the addition of fines, providing the open gravel mix will develop adequate stability. Instead of using this oil, which is composed of approximately 75 per cent soft asphalt residue, fluxed with gas oil or lube fraction distillates, a heavy mixing grade of cutback asphalt or an asphalt in the nature of a heavy paving flux could be used to advantage. The cutback would cost more than the flux.

Another instance of the absence of economy in bituminous treatment is the case of a state which for several years used millions of gallons of road oil as a dust layer on gravel roads. This oil penetrated and volatized so quickly that in many cases only loose brown aggregate remained after a few months' traffic. The oil had a cracked residual base and a volatile diluent and lacked ability to bind and resist weather. Such an oil would undoubtedly be suitable for priming purposes but is certainly not permanent enough for surface treatment and dust-palliative work. Frequent applications were necessary, and the producer sold enormous quantities of the oil. Obviously this sort of treatment could cost as much as building and maintaining a pavement, whereas the use of the proper grade of high-class oil would develop a mat highly resistant to weather and capable of giving good service at low cost.

Treatments classified

A fairly complete program of bituminous treatment of roads calls for four general classifications of bituminous materials with various modifications to suit traffic, subgrade, available aggregates and climate. These are as follows:

1. Priming material for treatment of subgrade in advance of surfacing. Obviously, such materials should be very liquid at application temperature, should penetrate readily and need not be of the highest quality with respect to weathering. This affords one use for cracked-base oils that is fairly safe from the

dangers attending direct exposure to weather. Priming is worth while in the case of light surface mats as well as for the more substantial mixed courses.

2. Dust layer and surface-treating materials may not be of substantially the same grade. However, a single grade does serve the dual purpose in the case of traffic-bound gravel and stone roads. High clay content requires greater penetrating ability than the more open structures resulting from its absence. The development of surface mats is sometimes undesirable, especially in the treatment of earth roads. In such instances a non-binding oil is desirable. Where mats are desirable, oils of good binding and weathering quality are essential. Bitumens in this class may vary from very liquid to heavy hot-application binders, depending upon the exact local conditions. First treatment of gravel will normally call for a fairly liquid material, whereas retreatment solely for the purpose of mat renewal requires either a quick-drying, heavy-base, cold-application material or a heavy hot-application binder.

3. Road-mix binders should be of high quality, and their permanent liquidity will vary mainly according to the amount of fines in the aggregate. All-fine aggregates in general require slow-drying viscous binders. Cutbacks of the naptha or kerosene type are not desirable. Various degrees of modification are necessary for use on aggregates between all-fine and all-coarse, with the all-coarse type requiring very stable high-quality binders, capable of adhering to the aggregate in thick films because of the openness of the structure. If cutback material is used for this purpose, it should be of the heavy type which sets in thick firm films reasonably soon after manipulation. Heavy hot-application binders may also be used.

4. In general, binders for plant mix follow the rules applicable to road mix, except that they do not have to retain their temporary liquidity for so long a time since mixing is quickly accomplished. This permits the use of an even more viscous binder.

Engineering skill necessary

It is apparent that the more stable the binder is over the range of temperatures obtaining, the more stable will be the bituminous structure. This should always be borne in mind regardless of the type of surfacing under consideration. The only danger in this direction exists in the case of hard paving asphalts that may be too hard to afford good cold-weather resistance. But such materials are outside the scope of this discussion. Liquidity is required only during mixing and placing, and is therefore temporary, regardless of whether it is accomplished by heating, dilution or emulsification. In the finished pavement a certain amount of workability or malleability may be desired, but liquidity as such is not wanted. This is fundamental and should never be lost sight of in selecting a suitable binder for a given purpose. The use of heat together with partial dilution will often solve an otherwise difficult coating and manipulating problem.

In the beginning it appeared to some that engineering principles could be discarded in the case of low-cost bituminous roads. It is now clear that this class of work follows the well-known general rule that the less money available for a given purpose, the finer drawn must be the engineering acumen applied thereto. This may be bad news to some material salesmen who thought they had at last come into a bonanza period, but it is nevertheless true and is becoming more generally appreciated every day.

Low initial cost followed by high maintenance expense may easily ruin the whole scheme of low-cost roads. The real cost of any engineering project is not today's cost as the job is being built, but tomorrow's and next year's cost for a considerable time to come. Failure to recognize this unavoidable truth has resulted in much waste of valuable road funds by inexperienced road officials who considered engineers and specialists more or less excess expense. The man who knows or can find out is always worthy of his hire.

Low-cost highway programs have opened a way for enormous savings, but the money so spent must be wisely spent or these programs will follow in the path of all poorly executed schemes. Because of limited funds per mile of required highway, extraordinary precautions must be exercised to make those funds do the most possible. This means a careful survey of the needs and available materials, followed by intelligent planning and high-grade construction under experienced men backed by specifications drawn with a thorough knowledge of the requirements of the job and the limitations of the materials to be used. The past few years have demonstrated conclusively that the highest order of engineering skill and scientific knowledge are absolutely essential to really low-cost bituminous roads.

Integral Abutment and Pier Feature Grade Separation

Tracks of Toledo Terminal Railroad carried over Dixie Highway on a plate-girder bridge with center span of 51 ft. and side spans of 8 ft.—Drainage handled by automatic pumps

ELIMINATION of the customary center pier and use of an integral abutment and curb-line pier footing is a feature of the new grade-separation structure that carries the double tracks of the Toledo Terminal Railroad Co. over the Dixie Highway north of Toledo. Steel column bents at the curb lines, in combination with the abutments, support four lines of 60-in. plate girders in three spans of about 8, 51 and 8 ft., respectively. The bridge is set at an angle of 65 deg. with the center line of the highway. Other notable features of the project include the substitution of a riprap embankment for a costly retaining wall, slag backfill behind the abutments, automatic pump drainage, a gutter behind the sidewalk along the approach cut and a novel center walk between the tracks. The grade separation was designed and built by the Toledo Terminal Railroad Co. and was jointly supervised by the engineers of the railroad and the Ohio state highway department.

At the request of the state highway officials a center-pier design was abandoned in favor of clear-span construction, and by making use of an integral abutment and side-pier footing the cost was found to be essentially the same as that of a center-pier design. As shown in Fig. 2, the abutment footing was extended inward under the sidewalk and partly under the pavement to provide support for the side pier. This toe was designed for maximum moment just inside the side pier. The toe and a portion of the abutment up to the sidewalk level were extended lengthwise to accommodate a future four-track railroad; this procedure insures the necessary integral construction below ground, and at the same time will make it unnecessary to tear up the street for the future construction.

The side piers support steel column bents upon which the plate girders rest. Base plates 3 in. thick are used under the columns to insure an equal distribution of load to the footing. Located entirely above the sidewalk level with no concrete embedment, the base plates are easily available for inspection and painting. The superstructure is not particularly notable. The plate girders are spaced as shown in Fig. 2. On top of the two center lines of girders a checkered plate was riveted to support a walk of 2 in. of asphalt mastic. Provision is made on the two outside main girders for future walks when additional tracks are added.

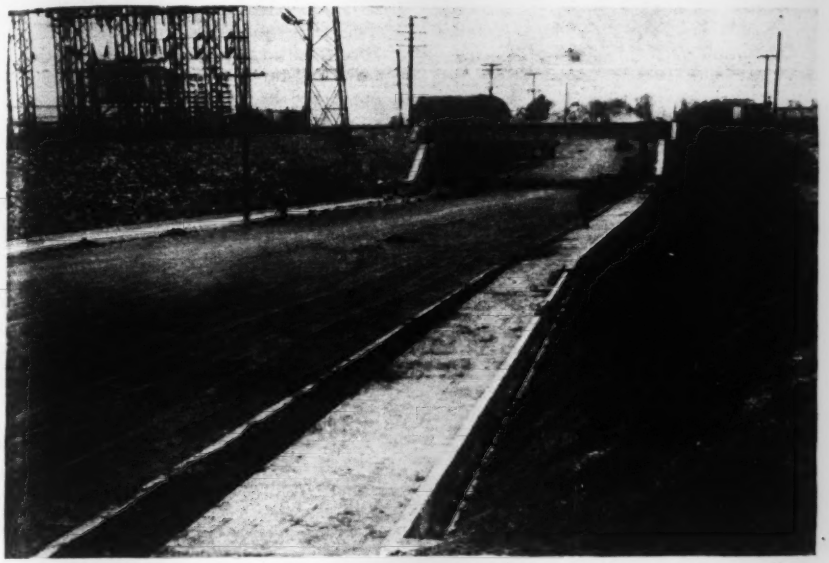


Fig. 1—Grade separation of tracks of Toledo Terminal Railroad and Dixie Highway. Clear span over street is accomplished by curb-line bents. Drainage is handled by automatic pumps located in a sump at the far corner of the left abutment. Note gutter on inside edge of sidewalk to catch slope drainage.

Abutment backfill is slag, which was adopted to reduce settlement to a minimum, since the bridge deck drains off each end. Six-inch cast-iron weepers, with a downturned elbow on the back side of the abutment and straight Y on the inside, run through the abutment to the roadway curb. A bronze plug in the straight leg of the Y furnishes easy access for cleaning by rodding. The other leg of the Y is turned down and connects to an intercepting pipe under the walk for drainage to the sewer.

The 50-ft. roadway of the Dixie Highway is led under the bridge on 4 per cent grades, ascending and descending, extending about 600 ft. either way from the structure. The subgrade of the pavement is drained by 4 in. of stone screenings and an open-joint herringbone system of 4- and 6-in. tile pipes. Disposal of drainage water presented a problem. Gravity drainage to a sewer proved too costly, and gravity drainage to a near-by creek was impossible. Pumping into the creek was finally resorted to. All drainage is concentrated in a sump at the southeast corner of the bridge. From here it is pumped, by float-controlled, electrically driven centrifugal pumps, to a sewer emptying into the creek.

The pavement is brick on a concrete base. Eight-inch traffic markers, forming 10-ft. traffic lanes, consist of cream-colored glazed brick. A coat of undiluted commercial glycerine was painted on these colored bricks before they were laid, in order to facilitate the removal of any asphalt filler that might adhere to them.

Along the southwest side of the project an embankment riprapped to line and grade was substituted for a proposed costly retaining wall, effecting a saving of about $20,000. Support for a high transmission tower of the Toledo Edison Co. and removal of other structures of a high-tension substation falling on the embankment necessitated the purchase of a slope easement, or else moving the whole station back from the street, which would be a decidedly expensive proceeding. Large concrete-block foundations were placed under the two near legs of the transmission tower, and certain minor structures were moved entirely off the embankment. The slope of the riprap varies from 1½ to 1 up to 1 to 1 at the tower.

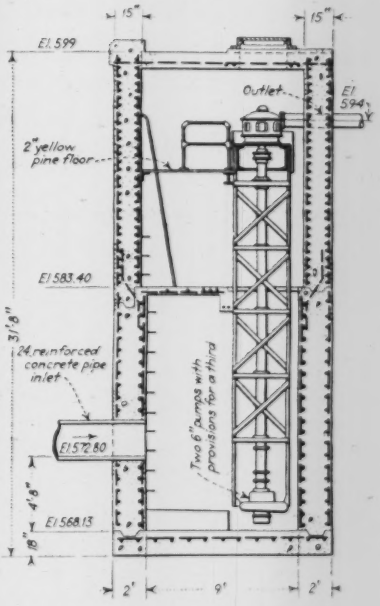
Purchase of additional right-of-way for a berm at the base of the side slopes was avoided by building a combination curb and gutter along the inside edge of the walk. The 6-in. curb is 4 in. thick, and the gutter is 6 in. deep with an 8-in. semi-circular bottom. This special gutter prevents dirt and slope drainage from flowing across the walk and relieves the roadway gutter flow considerably. It drains into the sump system.

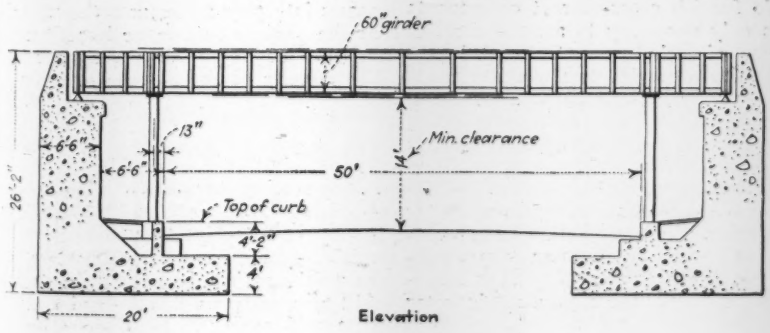
Fig. 2—Integral abutment and side-pier footing is a distinguishing characteristic of the underpass structure. Slag fill is used behind the abutments to aid drainage.

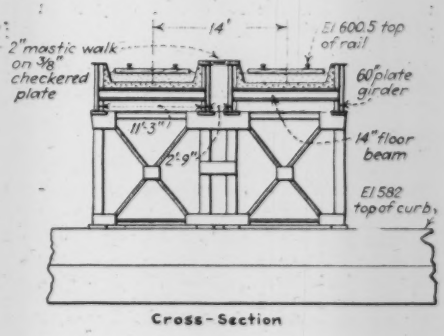
Personnel

Supervision personnel consisted of the following: A. B. Newell, president and general manager, and F. J. Bishop, engineer of bridges and buildings, Toledo Terminal Railroad Co.; J. R. Burkey, chief engineer, bridges and grade separations; and R. J. Wisda, Ohio state highway department.

Fig. 3—Section through drainage sump. Float-controlled pumps lift water to a sewer discharging into a near-by creek.







Letters to the Editor

Flow of Water Around Bends

DUE TO an error, this letter was published incompletely in our issue of Oct. 26. It is reprinted here with the necessary paragraphs added. —EDITOR.

Sir—You have recently published some articles on the flow of streams around bends; but none has presented a mathematical reason for the transverse movements therein. The following discussion therefore may be pertinent.

At any point in any stream flowing around any bend at any circumferential velocity, the relative velocity at the free surface and at any other point along a vertical line extending to the bottom may be represented fairly by a plain parabola or some other nearly equivalent curve.

The free surface may be level or sloping, up or down, on a straight or curved line in any direction, wave-like, or "choppy," without materially affecting what follows.

Assume a vertical reference line at a distance r from center of curvature of the bend at any point under consideration; let v denote the circumferential velocity at or near the free surface, and m the mass of any convenient unit of volume of water.

At some point along the reference line, either at or near the bottom, there will be a point where the circumferential velocity will be only one-quarter that at the top or near the free surface; denote the velocity at or near the bottom by v_1.

The weight of equal volumes of water, or water and solids in suspension, at the surface and bottom will probably not vary over 1 per cent; so our error will be small if m is considered constant.

In its simplest form the centrifugal force developed by any unit of volume of matter moving in a curved path is expressed by the equation $f = m\,v^2/r$—in which f is the centrifugal force.

We then have, for any unit of volume:

At or near the free surface—

$$f = (m/r)v^2$$

At or near the bottom—

$$f_1 = (m/r)v_1^2$$

Since m and r are constant at any point considered and $v_1 = v/4$, we have the radio $f/f_1 = 16$.

At all intermediate points along the reference line the ratio will vary from zero to less than 16.

Similar unbalanced conditions will exist at all points within the limits of the stream in the bend.

Variations in the value m have little effect on the ratio. If the weight of the water at the bottom was in excess of that of solid lead, an unbalanced condition would still exist.

Nature has ordained that, in fluids, energy in the form of pressure or velocity is mutually convertible either wholly or in such parts as may be required in order to stabilize conditions.

In a "free-surface" stream the excess pressure is in part relieved by transverse motion of the water at low velocities, resulting in helicoidal flow. A part is then consumed by friction, and the remainder produces superelevation at the outside of the bend.

A transverse flow, outward at the top and inward at the bottom, is the only means provided by nature to establish equilibrium.

JAMES W. PEARL.

Chicago, Ill.,
September 30, 1933.

Bed-Load Drift Across Current

Sir—The actual laboratory observations on "Bed-Load Drift Across Current" at river bends, as described in the July 13 issue, p. 41, and as discussed in the Sept. 14 issue of *Engineering News-Record*, p. 326, are particularly noteworthy because of the discordant views held by writers on river hydraulics. For example, note the statements that there was found no single instance in which the currents moved according to the prevailing helicoidal flow theory, and that the material moved at an angle with the directions of the currents by which it was transported.

The centrifugal analogy of your correspondent (p. 327), though interesting, appears to me hard to reconcile with the ordinarily accepted mathematical deductions concerning the several forces in a water whirl; for instance, see pp. 121-133 of Perry's "Calculus for Engineers." It is hardly safe, in attempting to deduce static inequalities of hydraulic pressure, to proceed from the configurations which are assumed by particles moving in dynamic equilibrium.

Those who develop their own photographs must have noticed how the undissolved precipitate accumulates near the center of a cylindrical bottle in the zone of minimum velocity; likewise at the nodes of waves formed by rocking a rectangular tray, reproducing on a small scale the formation of sand ripples in shallow water.

To furnish cross-current components it is only necessary to assume a slight degree of turbulence. Suspended particles then chancing to move into zones of low velocity will there accumulate, forming bars; all others chancing among currents of competent velocity continue on downstream comparatively unnoticed.

G. K. Gilbert's *Professional Paper* (U.S.G.S. No. 86) on the "Transportation of Débris by Running Water" describes the rhythms of débris movement initiated by rhythms of water movement; some related to space, some to time, others to both space and time. The interaction of several constant forces naturally develops diversities of flow. Starting from an artificially smoothed bed, the débris particles begin moving in a series of spots separated by uniform intervals, first creating a system of dunes. When the sand sweeps steadily forward over the whole area of the bed, this so-called smooth phase of traction is due to mutual cancellation of dune and anti-dune opposing rhythms. These rhythms should be susceptible of analytic treatment.

The difficulties of hydrodynamics, however, were well illustrated by a published solution of the curved path of a pitched baseball. Experiment showed it actually curved in the opposite direction. The postulated resisting cushion of compressed air had less influence on deflection than did the partial vacuum, which had not been noticed.

ROBERT H. MERRILL,
Consulting Engineer.

Grand Rapids, Mich.,
Sept. 25, 1933.

* * *

Sir—In *Engineering News-Record* of Sept. 14, p. 326, R. H. Britt gives what I believe is the true explanation of the phenomena by which material transported along the bed of a model of a bend in a stream tends to move from the outside to the inside of the bend. It would perhaps be worth while to put the argument in mathematical and therefore quantitative form.

Let a particle whose volume is V be moving with the water at a velocity of v_1 ft. per second around a curve of radius R ft. Let the density of the water be ρ_1, the density of the particle be ρ_2, both in slugs per cubic feet, and let $\rho_2/\rho_1 = s$. Then the outward centrifugal force will be $\frac{\rho_2 V v_1^2}{R}$. The inward component of the buoyancy will be just equal to what the centrifugal force would have been had the particle been replaced with an equal volume of water—that is, $\frac{\rho_1 V v_1^2}{R}$. Therefore, the net outward force will be $\frac{V v_1^2(\rho_2 \rho_1)}{R}$ and the particle will tend to settle in an outward as well as a downward direction.

But when the particle touches the bottom, the backward drag of friction comes into play and causes the velocity of the particle to become less than the velocity of the water. Suppose that the velocity of the particle becomes v_2. Then the outward force is only $\frac{\rho_2 V v_2^2}{R}$ and the net outward force becomes $\frac{V}{R}(\rho_2 v_2^2 - \rho_1 v_1^2)$. If $v_1 = v_2\sqrt{\frac{\rho_2}{\rho_1}} = v_2\sqrt{s}$, the particle will move in the same direction as the water. But if $v_1 > v^2\sqrt{s}$, as would ordinarily be the case, there will be a net inward force and the particle will move at an angle with the

water. Now, however, the friction will have an outward component and for steady motion we will have

$$\frac{V}{R}\ (\rho_1 v_1^2 - \rho_2 v_2^2) = f\ g\ V\ (\rho_2 - \rho_1)\ \sin\theta$$

where f is the coefficient of friction, and θ is the angle that the direction of the particles makes with the direction of the water. Solving this, we get

$$\sin\theta = \frac{(\rho_1 v_1^2 - \rho_2 v_2^2)}{R f g\ (\rho_2 - \rho_1)} = \frac{v_1^2 - S\ v_2^2}{R f g\ (S-1)}$$

This formula is only approximately correct, because it neglects the fact that the radius of curvature of the path of the particle will be somewhat different from that of the path of the water, also because it neglects the resistance that the water will offer to the inward motion of the particle. It might also be noted that with the ordinarily shaped particle, the motion will be a rolling rather than a sliding, as there will be a couple about each of the horizontal axes, and these will combine to cause rolling in the general direction of the motion. But these minor points will not affect the general truth of the formula.

By substituting assumed data it is found that in an actual river where R is large, θ will be very small and the particle will follow very nearly the path of the water (which may, however, be somewhat transverse according to the helicoidal theory). But in a small-scale model R will be much less and θ will be larger, so that the effect will be exaggerated unless the ratio of velocities is kept proportional to the square root of the horizontal scale ratio. Since this was probably not done in the distorted models used at Vicksburg, it raises a doubt as to whether such experiments can be depended upon to predict the path of material around a bend.

RALPH W. POWELL,
Ohio State University.

Columbus, Ohio,
Sept. 27, 1933.

Development of Engineering Education

Sir—As I sense the development of engineering education, there is a definite obligation to accept the trend of the present industrial program and its social implications. In my opinion there will be no retreat from the advanced position taken by eliminating child labor, by decreasing hours of labor and by setting certain wage ideals—which latter may not be reached at once. Evolution is a slow process, with many causes of friction within its mechanism as well as traditional resistance to change. Time is of the essence of such radical changes. A ready instrument of management thinking is necessary on the part of many not in the engineering profession but whose mental processes and precedents have had a dominating influence on engineering. The banker, the investment broker, the old-line "boss" face forces that will change their procedure or leave them in the ruck.

Either banking must change or it will be subjected to some form of regulating to save the banker and the investor. The engineer is deeply concerned with investment banking, since his reports should determine the soundness of new issues in many fields.

The engineer is also in the best position to assist in deciding on public policies concernng improvements for slack-water navigation, canals and national highways and public works. These have frequently been decided on political grounds or as a result of emotional appeal. Frequently but little factual information has been given the public on which to form a rational judgment of the economic worth of a public expenditure.

In the above fields the evidence of engineers is vastly important. In the remoter subjects of economics the engineer is at no disadvantage, since his training and experience should be a valuable guide to him in determining whether a controlled industry and a planned economic program will adjust supply and demand, wages and hours, technology and biology to a new business cycle.

It is clear that the engineer must be more of a citizen and more courageous in taking a public position on public questions. He has been silent for fear of being unprofessional or from lack of interest. The majority of governmental policies concern the engineer and his work. The doctor and the lawyer do not hesitate to speak. Their professions expect it of them.

In view of these sketchy considerations, I believe that in our education we should dwell more on the part which the engineer should play in the discussion of public-works projects. He is trained in honest, square-faced thinking. We need just that form of courage in the consideration of present and proposed programs of public business. The curricula need not be changed, but emphasis should be placed on the social results of engineering.

Our technical journals are media of education and should be alert for two reasons. First, the profession of engineering faces new problems; second, the engineer must re-orient himself in this changing world. The *Journal* of the American Society of Mechanical Engineers has published a number of articles on industrial economics which have been among the soundest studies of our present evolution. There have been criticisms of the editors for departing from the traditional scientific and descriptive articles, but it is high time that the engineering profession saw further ahead and became more alert to its responsibilities and opportunities.

The joint program on economics at the Chicago group of engineering conventions was good evidence that the leading thinkers are aware of the trend of powerful social and industrial forces which are impinging on the work of the engineer. Journals devoted to the larger interests of engineering should assist the profession in adjusting its thinking and in making articulate its cautiously considered judgments. No other profession or segment of our civilization has more to say that is worth saying—if they know how to say it.

R. L. SACKETT,
Dean of Engineering,
Pennsylvania State College.

State College, Pa.,
Sept. 11, 1933.

Engineers' Code Hearing Report

Sir—In reading the report of the hearing on the engineers' code in the Oct. 12 issue of *Engineering News-Record*, I note that but two of the points raised on behalf of the state society are mentioned—namely, amendment to the definition and minimum wage for engineering assistants. I believe that some mention also should be made of the two really major points with respect to the administration and the making up of the national control committee and of the state or regional committees having to do with the fixing of the compensation. I know of no better way to get it before the engineering profession than through *Engineering News-Record*.

We raised the point that the national control committee should be composed of a member from each of the national organizations which shall have subscribed to the code within ten days, subsequent to its approval by the President, and in addition two extra members from the American Society of Civil Engineers, together with representation from the engineering assistants. The code as printed for hearing provided that only those societies that had subscribed to the code one day but one prior to the hearing should have membership on a committee. We felt that this was wrong, inasmuch as there might be people subscribing to the code in its final form who did not feel justified in subscribing prior to the hearing. Also we felt that the engineering assistants should have representation on such a committee.

It also was our contention that on any regional or state committee a recognized and established state society of professional engineers should have not less than one-third of the members of any committee confined solely to a state and, if a regional comimttee, not less than one-third of the members from its particular state on such committee.

We also contended that on the regional committees there should be representatives of the engineering assistants group who, as you can readily appreciate, would not be eligible for membership in the state society or in any of the national societies as corporate members.

ARNOLD G. CHAPMAN,
President, New York State Society of Professional Engineers.

Albany, N. Y.,
Oct. 14, 1933.

Engineering News-Record

EDITOR—F. E. Schmitt. EDITORIAL STAFF—V. T. Boughton, W. G. Bowman, F. W. Herring, C. S. Hill, H. W. Richardson, W. W. De Berard, N. A. Bowers, J. I. Ballard.

Editorial and Publishing Offices at 330 West 42d St., New York; 520 North Michigan Ave., Chicago; 883 Mission St., San Francisco; Aldwych House, London, England. Subscription price $5 per year in the United States; foreign rates on application.

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November 9, 1933 Volume 111 No. 19

In the News

AUTHORIZATION of a large PWA loan to the Pennsylvania Railroad insures immediate resumption of its New York-Washington electrification and will create much employment before winter. *** The Tennessee Valley Authority, by calling for bids on a heavy-duty highway to the site of Cove Creek Dam, puts to rest the rumor that the TVA is going to do all its work by force account. *** The TVA at last is on a solid revenue basis by signing its first contract to sell power to a municipality. *** Last week the PWA, when it found that the state of Georgia could not borrow money from it for a prison, agreed to build the prison and lease it to the state; this first use of the leasing provisions of the Recovery Act raises the question why the PWA has not been willing to apply it before now. *** The PWA has aligned itself with a radical policy toward utilities by announcing that municipal power projects are "on the preferred list." *** In stating that it had sent out 200 bond-purchase and grant agreements for $113,000,000 of non-federal work up to Nov. 1, three-fourths of all being straight grants, the PWA proves that despite its efforts the legal difficulties are effectively checking loan projects. * * When October's concrete output at Boulder Dam reached the unparalleled total of 204,572 cu.yd., it gave fresh evidence that the work continues to move at record-smashing rate; the figure means that more than 25 carloads of cement and 12,500 tons of concrete were handled every working day.

To Provide Employment Quickly

LAST WEEK'S authorization of PWA loans to finance a million tons of rails and other track steel was followed within a few days by preliminary approval of a loan of $84,000,000 to the Pennsylvania Railroad for completing its electrification to Washington and buying several thousand new freight cars. Since these loans will create a large amount of work almost at once, it is fortunate that they were not tied up by the hopeless delays to which municipal loan applications have been subjected through lack of legal decentralization. An equally ready means of quick employment has been wholly neglected, however. This is the elimination of dangerous grade-crossings, a type of work on which, it has been estimated, a hundred thousand men could be given employment within thirty days. In spite of the number of crossings at which human life is in daily jeopardy and in spite of the fact that plans for grade-separations at many of these crossings are ready, little action has been taken by the Public Works Administration to start the work. Whatever the reasons for this inactivity, the failure of the PWA to create jobs anywhere near fast enough to relieve the unemployment emergency in measurable degree justifies their immed[illegible] reconsideration. The Recovery Act makes the Pu[illegible] Works Board responsible to the people for just [illegible] thing—to finance work that will *provide employm[illegible] quickly*, while meeting public needs. Grade-cross[illegible] elimination is one of the prime means by which t[illegible] responsibility can be discharged.

Light Bridge Floors

BRIDGE ENGINEERS who in recent years ha[illegible] been searching actively for lighter types of brid[illegible] floor will find an interesting new contender in the rec[illegible]-structed Smithfield St. Bridge at Pittsburgh, opened [illegible] traffic last week. Aluminum here sees its first use in t[illegible] bridge field, and this under noteworthy conditions, f[illegible] its lightness and the effective way in which it was appli[illegible] to the special circumstances of the case enable the c[illegible] authorities of Pittsburgh to continue in service for ma[illegible] years a structure that has long been officially rat[illegible] obsolete. By mere elimination of weight, the load on t[illegible] bridge has been reduced as much as if the traffic load ha[illegible] been cut in half. It needs no argument to prove t[illegible] importance of such load relief in the case of old bridge[illegible], often loaded more severely than is considered safe for a new bridge. Details of the reconstruction, which involved the replacement of the old floor of wrought iron, steel and timber by a floor of structural aluminum and bituminous surfacing, will be given in an article to appear soon. One prominent element of the work is a new alloy claimed to be as strong as silicon steel. Another is a ribbed slab floor of joist-and-plate-metal construction that was found by test to offer a satisfactory degree of lateral continuity. The reconstruction thus bears in more than one way on bridge economy questions.

Conservatism Has a Place

THE new-deal spirit that is influencing financial and industrial matters so extensively has not been without effect on technical thinking, it appears. Engineers concerned with cement, at least, seem ready to depart from past ways. The doctrine that one and the same cement will suit every service is now questioned rather widely, and specialized cements are being demanded. The low-heat Boulder Dam cement has been followed by a new cement adopted for the Golden Gate Bridge piers and by calls for special mixtures for federal lock-and-dam work. These are individual instances of the trend of technical opinion. Essentially it is a sound trend, and one which we have long advocated, yet it involves a risk that should not be lost sight of—the risk that engineers will undertake to build important structures of untried materials merely because these materials look good, or are supported by plausible claims, or have passed good short-time tests. This would be quite like the conduct of a patient who, losing faith in approved prescriptions, falls to reckless indulgence in patent medicines. Wise conservatism has an important place in a field so intimately tied to long-time experience as that of hydraulic cements. Should American practice reach the point of specifying or accepting a new cement for every job, it might find itself in a condition even more complex than that revealed by the proposed French specifications reported on another page of this issue. Worse still, lacking the support of the accumulated experience on which that specification evidently rests, it might accept conclusions reached abroad, without regard to the differ-

ence in conditions involved. A serious setback to cement and concrete practice would be inevitable.

Stabilizing Earth Roads

A DEFINITE ITEM of experience has been contributed toward the solution of the important problem of treating earth-road surfaces to secure stability against displacement and disintegration by recent earth-road work in New York and Michigan. The specific experience of Onondaga County, N. Y., which is carrying out an unusually vast program of earth-road stabilization, was outlined in our last issue. There the objective was to indurate a mixture of gravel, sand and clay by impregnating its surface layers with a water-retaining or hygroscopic chemical. The object of the other direction of effort has been a chemical treatment having a positive cementing action by crystallization. At present the use of hygroscopic salts with a stabilized soil mixture has reached farthest toward success, but experiment is proceeding with chemical applications that will modify the characteristics of soil. The objective of both lines of experiment is highly important in those large areas throughout the world where only the directly adjacent soil is obtainable as material for constructing the body and surface of the road.

The NRA On Trial

THE CONSTRUCTION code still waits approval at Washington. As this is being written it is reported that the code is going through the decisive stage of its battle for NRA approval. The battle is in effect a test of the wisdom and determination of the construction industry. But in even greater degree it is a test of the National Recovery Administration itself.

For weeks the code has been under persistent partisan attack. Interests that desire to obtain special advantage from dissension and failure of cooperation oppose its approval, seeking to destory the regulatory safeguards that it would establish. Already they have held up approval for many weeks, while the progressive elements of the industry throughout the country waited anxiously for constructive action. Anxiety is turning to concern as each added day brings further injury to construction and to the country as a whole, which is vitally concerned in that industry's health. Just now the attacks are at bitterest intensity, and the danger is that they will break down the determination of the NRA.

Unity of the construction industry is the issue in the present battle. The outcome will decide whether effective self-government is to be realized. In each of the separate units of the industry, from engineer to subcontractor, the responsible leaders well know that progress can be attained in no other way than through integration under one broad constitution and one governing authority. They know that, like other industries, construction suffers form many harmful practices born of cut-throat competition, chiseling and other evils that necessarily follow where industry-wide enforcement of quality and integrity is lacking. But the evils are intensified by its own disorganized state. Though its separate groups serve a single purpose—that of constructing the nation's necessary improvements—yet they have stood apart from each other, often in hostile attitude, and will remain so while they lack the integration and balanced self-government made possible by the code.

Manifestly the harmony and cooperation brought about by the code will be helpful to everyone, from client to worker. Nevertheless certain shortsighted leaders of labor seek to wreck the code. Other attacks are led by small groups that see only their fancied self-interest. Blindly or selfishly these objectors fail to perceive that the code will operate as powerfully in their own service as in that of any other group—that none can prosper until construction activity is largely increased, and that no one group can be secure or stable without basic reform of the evils that affect them all.

The present battle is a test of the construction industry. It must demonstrate to the NRA that it is inspired by a strong purpose to achieve integration and set its house in order. Can it show, in a way to convince even the skeptic, that unity under a broad basic code is possible and will be of value to all? Is the industry sufficiently farsighted and courageous to persist in its fight against the plausible but sterile expedient of a multiplicity of uncoordinated codes? These questions will find their answer in the manner in which the code committee carries through its battle and in how strongly it is supported by engineers, contractors and subcontractors throughout the country in a demand upon the NRA officials to promulgate a single unified code.

For the NRA itself the issue represents an even greater test. The Recovery Administration is here on trial; its sincerity and courage are under fire. In its wisely chosen course of establishing the country's major industries in large coordinated groups it now comes to the point of severest challenge, where it must either maintain its course by establishing one of our very greatest industries as a unit or else, defeated, retreat to another position. It cannot retreat without stultifying itself. Nor can it hope to keep its essential purposes intact if it yields before the present attacks; it would lose the respect of the industrial nation, upon which its future operating effectiveness depends.

Thus, unless the now incoherent units of the construction industry are definitely integrated into a unified structure by a single code the NRA will have made a major failure, and indeed a critical one. Its past successes will count for little if it fails in the present battle. The problems at issue, though different in nature from those of the steel and coal industries, are of far greater importance, for they involve the elimination of racketeering and unsoundness in an industry of three million workers, one that is more sorely troubled by these cancerous ills than any other.

Let it be remembered, too, that construction is the agency on which the country depends for the all-important function of investment of its savings. The surplus of the rich and the produce of self-denial of the poor alike find a repository through investment in the structures which this industry erects; and these savings are secure only to the extent that construction operates efficiently and soundly. The NRA, therefore, can have no greater responsibility than to assist in placing that industry on a stable basis, in order that the savings of the people may be protected against depletion and wastage.

NEWS OF THE WEEK

Large Loan Made for Rail Equipment and Construction

THE Public Works Administration, on November 2, authorized the allotment of $135,000,000 to railroad companies for rails and fastenings and for new construction operations. Of the total, $51,000,000 was set aside for loans to railroads for the purchase of 1,000,000 tons of rails and 400,000 tons of fastenings under the agreement recently reached between the President and the steel companies, calling for a price of $36.375 a long ton for rails.

Pennsylvania electrification

A loan of $84,000,000 was authorized to be made to the Pennsylvania R.R. Co. for the completion of its electrification program between New York and Washington and for 7,000 freight cars. The principal items of the Pennsylvania electrification program are: $15,850,000 for carrying the electrification work through to Washington, for both passenger and freight operation; $16,525,000 for 132 electric locomotives; $1,087,000 for 23 multiple-unit passenger cars; $2,611,000 for tunnel work at Baltimore, Md.; $2,041,000 for the Virginia Ave. tunnel in Washington; and $750,000 for reconstruction of the railroad tracks at Elkton, Md.

The construction work covers fabrication and setting of 2,500 towers; changes at Elkton, Md., to eliminate grade crossings, reduce curvature and add tracks; improvement of the Union Tunnel at Baltimore and construction of a new double-track tunnel there; reconstruction of the Virginia Ave. tunnel at Washington; and construction of additional electrification facilities at Washington.

Of the total loan to the Pennsylvania R.R., $78,000,000 will be spent by the end of 1934 and the balance in 1935. The Pennsylvania already has spent $67,000,000 on the electrification program, of which $27,500,000 was borrowed from the Reconstruction Finance Corporation and has been repaid. That money was borrowed at 5½ per cent; the loan now authorized ,if consummated, will be at 4 per cent. Work on the electrification program was practically suspended last spring. It is understood that the terms of the loan will allow 15 years for repayment on cars, 20 years on locomotives and 30 years on roadway and structures.

Activated-Sludge Case Hearing

Oral arguments on the case of Activated-Sludge, Inc., vs. Sanitary District of Chicago, will be heard before Judge Lindsey, federal district court, Chicago, on Nov. 27, and argument on the Milwaukee appeal before the Court of Appeals will be heard on Dec. 5. For details of the Milwaukee decision see *ENR*, Feb. 23, 1933, p. 264.

New Army Engineer District For Missouri River Work

Missouri River navigation flood control, power and irrigation projects are assuming such importance that the War Department has created a new division in the Corps of Engineers. Headquarters will be located at Kansas City, with district offices also at Kansas City and Glasgow, Mont. In charge of the new division is Lieut. Col. Richard C. Moore, for several years sector engineer in charge of Missouri River work. Capt. Theodore Wyman, now district engineer at Kansas City, is Col. Moore's assistant.

Major Thomas B. Larkin, district engineer in charge of the Vicksburg District, has been relieved of duty there and is being transferred to Glasgow, Mont., to be district engineer of the new district and to take charge of the construction of the Fort Peck dam.

Ole Singstad Named a Member of PWA Board of Review

Ole Singstad, New York, chief consulting engineer on tunnels, Port of New York Authority, has been appointed a member of the Technical Board of Review of the Federal Emergency Administration of Public Works.

Concrete Output at Boulder Dam Exceeds 200,000 cu.yd. in October

Concrete placed in the dam and power house at Boulder Dam on the Colorado river during the month of October amounted to 204,572 cu.yd., according to F. T. Crowe, general superintendent for Six Companies, Inc. This surpasses the record of 175,337 cu.yd. in September and brings the total to the end of October up to 630,271. The September yardage was distributed: dam and powerhouse footings on face of dam, 167,407 cu.yd.; spillways, spillway and penstock tunnels, 7,930 cu.yd.

During the same period the average daily production of concrete was 6,262 cu.yd. and the maximum day's run on the dam was 7,883 yd. By the end of the month the dam had been raised about to the elevation where the maximum number of blocks becomes available for placing concrete.

During the first ten days of October the daily average of concrete placed was increased to about 6,400 cu. d.

On Oct. 11 the refrigeration plant was started up and began delivering 40 deg. F. water to the cooling system in the lowest 50 ft. in the dam. In the next 50 ft. (vertical) of concrete, water precooled, by passing over the cooling tower, to about 70 deg. is being circulated in the cooling system. On Oct. 12 the high blocks were at Elev. 635 or almost 150 ft. above general foundation level. The low point of the cutoff trench is Elev. 505.6 making the total ultimate height to crest 726.4 ft.

Verde Irrigation and Power Project Gets P.W.A. Loan

AN initial allotment of $4,000,000 to permit the start of construction on the Verde irrigation and power project in Arizona, estimated to cost $18,912,000, has been authorized by the Public Works Administration. The 80,000 acres of land of the Verde project are situated in central Arizona on the north slope of the Salt River Valley, adjacent to the Salt River irrigation project and are embraced in the Verde Irrigation and Power District which was organized some time ago under the laws of Arizona. The district has no outstanding debt. The project is considered to be self-liquidating and the loan will be repaid by water users under the Reclamation Act. Part of the power will be used for pumping and the surplus will be sold.

It is hoped to build the Camp Verde reservoir, 950,000 acre-ft. capacity, the Horseshoe reservoir, 240,000 acre-ft., and the New River reservoir, 83,000 acre-ft. Cave Creek reservoir, built for flood protection for Phoenix, also will be available for storage. The plans call for construction of the McDowell-Paradise, Canal, the main canal, distributing canal and fifty pumping plants. Construction of eight power plants was proposed but the Bureau of Reclamation recommends that only four be built at this time.

Federal allotments

For enlarging and improving three harbors on the Ohio River $1,054,000 have been allotted to the Corps of Engineers. Work will be carried on at Huron, Sandusky, and Fairport. Small sums totaling $48,000 have been allotted to the Public Works Branch of the Treasury Department for miscellaneous construction to meet increased construction costs.

Swamp drainage

For the supervision of work of eliminating malarial swamp lands in the South and for improvement in community sanitation in twenty-one states the PWA has allotted $1,000,000 to the public health service. The Federal Emergency Relief Administration will supply $28,790,000 for the wages of workers and will select workers through its state organizations. The drainage work will be carried on in Alabama, Arkansas, Florida, Georgia, Louisiana, Missouri, Mississippi, North Carolina, South Carolina, Tennessee, Texas and Virginia. It is expected to cost $13,790,000 for wages other than supervision. Workers will be paid $15 a week. The community work will be carried on in the same states, also in Illinois, Indiana, Kansas, Kentucky, Maryland, Michigan, Ohio, Oklahoma and West Virginia.

Housing loan for Chicago

The first PWA housing project for the city of Chicago, that of the Harms Park Housing Corporation, near Western Ave.

and Berteau St., has received an allotment of $1,333,000 for a group of structures estimated to cost $1,569,400. The buildings are to be four-story walk-up, fire-proof apartments, containing 1,440 rooms to rent at $9.50 per room per month.

An allotment of $69,407 has been made to 16 private property owners at Brownsville, Tex., for repair of buildings damaged during the recent storm. The loan will be made through a Cameron County Emergency Relief Corporation, and will be secured by first mortgages.

Loans for municipal work

Allotments for 79 non-federal projects were approved during the past week. Details are given in the accompanying table. Most of the projects are for city and county work. The largest item is $7,500,000 to the Platte Valley Public Power and Irrigation District, successors to the Platte Valley Reservoir Association of Keith, Lincoln, Dawson, Buffalo and Hall Counties, Neb. The work includes a diversion dam, canal, reservoirs and hydro-electric power plant. Of the total about $1,500,000 will be a grant, the remainder will be secured by 4 per cent revenue bonds.

Red River flood work

A Louisiana delegation headed by Rep. Wilson, chairman of the House flood control committee, and Harry Jacobs, state engineer, urged at a hearing before the Mississippi Drainage Area Board and Deputy Administrator Waite, Oct. 30-31, that the federal government assume entire cost of flood control work on the Red River in Northwestern Louisiana which previously has been maintained by state and local funds. Rep. Wilson contends that the National Industrial Recovery Act does not limit the expenditure of federal funds for flood control to the Mississippi and its backwaters and such other work as may be done incident to navigation, as do prior statutes. Col. Waite takes the position that if PWA assumes the entire cost of work in Louisiana it would have to do so in other states. Rep. Wilson concedes this and estimates the cost at $700,000,000. Col. Waite puts the cost at $1,000,000,000.

Flood control in Oklahoma

As a result of the furore created in Oklahoma by Secretary Ickes' statement that land in the southwest drouth area might better be turned back to the public domain, PWA now is investigating the feasibility of building one of the proposed dams, that at Fort Supply, to combine additional water supply for Oklahoma City with its flood control function.

Post Office substation

An allotment of $14,208,400 for the extension of 86 postal substations in several large cities in the United States was announced by the PWA on Oct. 24, as noted in our issue of Oct. 26, p. 512. These stations, generally, are to replace rented stations. The allotments are as follows:

Chicago	18 postal stations,	$2,456,000
Boston	4 postal stations,	419,000
Brooklyn	13 postal stations,	1,517,000
New York	27 postal stations,	6,843,400
Cleveland	9 postal stations,	884,000
Philadelphia	12 postal stations,	1,803,000
Pittsburgh	3 postal stations,	286,000

The exact place of these structures has not been specified publicly, pending securing title to the land.

DETAILS OF PWA LOANS AND GRANTS FOR NON-FEDERAL WORK

Locality	Loan and Grant or Grant	Type	Man-Months Work Provided	Amount
Portland, Ore.	L. & G.	Watermains	32	$ 15,435
Manteno, Ill.	G.	Hospital	9,000	500,000
Fayetteville, W. Va.	L. & G.	Reservoir	300	67,000
Washington, Ind.	L. & G.	Sewer	1,800	150,000
Rochester, N. H.	L. & G.	Water	1,440	240,000
Prairie Grove, Ark.	L. & G.	Water	128	60,000
Reading, Ohio	L. & G.	Water	152	37,000
Brentwood, St. Louis Co., Mo.	L. & G.	School	270	60,700
Knoxville, Tenn.	L. & G.	Buildings	1,800	493,433
Worcester, Mass.	L. & G.	Streets	1,200	413,415
Junction City, Ark.	L. & G.	Water system	160	38,000
Victoria, Ark.	L. & G.	Waterworks	120	36,000
Grand View Heights, Ohio	L. & G.	Water	300	86,000
Cass County, Iowa	G.	Court house	500	32,000
Chambersburg, Pa.	G.	Power	490	24,000
Cincinnati, Ohio	G.	Sewer	30	1,000
Mitchell, S. D.	L. & G.	Sewer	910	174,000
Albuquerque, N. M.	G.	School	240	24,500
State of Utah	L. & G.	Schools	2,450	50,000
St. Louis Co., Minn.	L. & G.	Roads	20,160	490,000
Cass County, Iowa	G.	Roads	140	5,000
Meriden, Conn.	G.	Sewer	1,575	47,000
Cincinnati, Ohio	G.	Sewer	27	1,000
Cincinnati, Ohio	G.	Sewer	20	600
Cincinnati, Ohio	G.	Sewer	25	1,500
Cincinnati, Ohio	G.	Sewer	16	2,500
Claremore, Okla.	G.	Waterworks	50	1,700
Auburn, Maine	G.	School	360	34,500
Barre, Vt.	G.	Sewers	210	7,000
Owings Mills, Md.	G.	Building	650	34,000
Baltimore, Md.	G.	Building	390	32,000
Cincinnati, Ohio	G.	Sewer	13	600
Cincinnati, Ohio	G.	Sewer	20	800
Cincinnati, Ohio	G.	Sewer	315	11,700
Cincinnati, Ohio	G.	Sewer	380	13,500
Des Moines, Iowa	G.	Streets	25	3,400
Longmont, Colo.	L. & G.	Water	1,260	190,000
Hartford County, Conn.	G.	Sewage system	16,320	800,000
Platte Valley, Neb	L. & G.	Power-irrigation	38,400	7,500,000
Michigan City, Ind.	L. & G.	Water	1,530	413,000
Trenton, N. J.	L. & G.	Building	740	290,000
Hyattsville, Md.	L. & G.	Water	2,400	650,000
Lebanon, Conn.	G.	Roadway	580	45,600
Sommersville, W. Va.	L. & G.	Water	300	32,000
Bordentown, N. J.	L. & G.	Building	1,140	470,500
Annandale, N. J.	L. & G.	Building	315	75,000
Totowa, N. J.	L. & G.	Building	125	50,000
Annandale, N. J.	L. & G.	Block barn	48	18,955
Trenton, N. J.	L. & G.	Gymnasium	68	26,000
Vineland, N. J.	L. & G.	Hospital	160	47,250
Vineland, N. J.	L. & G.	Building	540	100,000
Annandale, N. J.	L. & G.	Barn and shed	48	15,200
Skillman, N. J.	L. & G.	Dormitories	392	144,500
Woodbine, N. J.	L. & G.	Laundry building	138	44,000
Skillman, N. J.	L. & G.	Dormitories	420	155,000
Skillman, N. J.	L. & G.	Building	288	95,000
Totowa, N. J.	L. & G.	Dormitory	320	77,000
Falls City, Neb.	G.	Sewer	45	2,500
Boone, Iowa	G.	Dam	60	11,000
Saffordville, Kan.	G.	School	150	7,900
Marion County, Kan.	G.	Culverts	30	1,800
Green Bay, Wis.	L. & G.	Asylum	960	300,000
Greeley, Colo.	L. & G.	Dormitories	700	286,000
Alexandria, Va.	L. & G.	School	864	300,000
Malone, N. Y.	L. & G.	Sewer	420	100,000
Fort Collins, Colo.	L. & G.	Power	800	738,000
Hopkinton, Iowa	G.	Paving	150	7,500
Utica, N. Y.	L. & G.	School	7,400	1,295,000
Van Zant Co., Texas	G.	School	10	600
Johnson Co., Kan.	G.	Bridge	30	1,300
Abilene, Kan.	G.	Building	60	2,400
Clay County, Kan.	G.	Highway	31	900
Baltimore, Md.	G.	Water mains	360	22,000
Des Moines, Iowa	G.	Pavement	13	950
Lovelock, Nev.	L. & G.	Water	400	106,000
Boulder, Colo.	L. & G.	Sewage works	490	72,000
Stevens Co., Minn.	G.	School	250	21,000
Chanute, Kan.	G.	Power	65	25,000
Utica, N. Y.	G.	Paving	450	28,000
		Total	124,968	$14,758,138

Contract Let Quickly For Aberdeen Water Project

Twelve days after the allotment of $700,000 to the city of Aberdeen, S. D., for its water supply project, the city let contract for pipe, valves and pipelines to the amount of $515,705.

Included in the project is a pumping station and water softening plant. The allotment was made on October 20 and the same day bids were asked on the work. Details of the contract are given in the construction news section of this issue. Alvord, Burdick & Howson, Chicago, are the engineers.

New York Seeks Large PWA Loan for Municipal Subway System

A combined loan and grant of $25,500,000 from the Public Works Administration for the city-owned rapid transit system is being sought by the city of New York, according to an announcement of the New York state advisory board. The money is to complete sections of the Independent System on which some work has been done and to equip the uncompleted sections. Sections upon which work has not been started, such as the 6th Ave. subway link, are not included.

The New York state board announced that it had forwarded to Washington applications totaling over $42,000,000 for projects throughout the state, including those for New York City.

Engineering Board Named For Grand Coulee Project

The Columbia Basin Commission has announced the appointment of a consulting engineering board for the Grand Coulee project on the Columbia River, consisting of W. Chester Morris, former city engineer of Seattle, member of the firm of W. C. Morris & Co., A. F. Darland, electrical engineer, Tacoma, and State Senator Horace Smith, consulting engineer of Okanogan, Wash.

Work Begun on Fort Peck Dam To Regulate Missouri River

Bids advertised for 15,000 ft. of boring for subsurface exploration of the Fort Peck dam site in Montana inaugurate the beginning of work on one of the largest storage reservoirs ever undertaken primarily for the improvement of river navigation. This great artificial lake located on the headwaters of the Missouri River in eastern Montana will have an estimated capacity of 17,000,000 acre-ft. and will involve the construction of an earth dam 230 ft. high with a diversion tunnel around one flank and a concrete spillway located some distance from the dam. A detailed topographical survey of the reservoir site and preliminary borings at the dam site have already been virtually completed as a part of the survey of the Missouri River basin by the Corps of Engineers, U.S.A.

The preliminary work arranged for immediate prosecution includes, besides the boring operations, a laboratory for soil analyses located at Glasgow, Mont., a 12-mile railway leading off the line of the Great Northern Ry., and camp facilities at the dam. As shown by the accompanying map, the dam is located on the Missouri a few miles above the mouth of the Milk River and the reservoir embraces the present mouth of the Musselshell River. The location and design of the dam proper are at present tentative and will depend on the foundation and soil studies now under way for final determination. The present work is going ahead under the recent allotment from PWA funds of $25,000,000, which is about a third of the estimated cost of the project.

Primarily, as stated, the purpose of the reservoir is to increase the low water flow of the Missouri River as a part of the present project for 9 ft. navigation. It will have important incidental benefits in providing power for irrigation pumping and in lowering flood heights in the lower Missouri. It is estimated that the reservoir will provide sufficient water to insure at all times a minimum low-water flow of 35,000 sec.ft. at Kansas City.

Missouri River watershed showing existing reservoirs and the site of the proposed Fort Pick reservoir in Montana.

Need for Winter Construction To Be Discussed by Contractors

Ways and means of eliminating the traditional winter lag in both private and public construction so that employment on the program of the Public Works Administration will continue to gain in impetus are to be considered at the fall meeting of the governing and advisory boards of the Associated General Contractors of America, to be held in Washington, November 13 and 14. It is expected that the association will urge upon the public works administration the need for speed in allocating money for public work and for seeing that the money is put to work promptly in order to set an example of the advantanges to be gained by continuous construction through the winter months.

One hundred per cent voluntary compliance to the letter and spirit of the code of fair competition for the construction industry and its general contracting supplement is to be urged upon the building, highway and engineering constructors of the nation, as the surest means of inducing a general construction revival, according to Edward J. Harding, managing director of the association.

Public confidence in the soundness of construction as the basic capital investment can be quickly restored through strict adherence to the reformatory measures that have been written into the construction code and its supplements, Harding believes.

E. O. Wattis Elected President of Boulder Dam Builders

E. O. Wattis, of Ogden, Utah, has been elected president of Six Companies, Inc., the general contractors for the construction of Boulder Dam on the Colorado River. Mr. Wattis was elected to fill the vacancy caused by the death of W. A. Bechtel in Russia on August 28. E. O. Wattis was elected first vice-president of the company following the death of his brother, W. H. Wattis, on Sept. 13, 1933, and the election of Mr. Bechtel to the position of president.

River Lock and Dam Work Being Rapidly Contracted

Of the 26 lock and dam operations called for in the plan of the army engineers for slackwater navigation of the Mississippi River from St. Louis to the Twin Cities, over half will be completed or under contract shortly after the first of the year. Dams 1, 2 and 3 in the vicinity of Minneapolis and St. Paul, Minn., are in operation, dam 15 at Rock Island, Ill., is partly in operation and, of course, the locks at the dam of the Keokuk, Ia., power development have long been in service.

Locks Nos. 4 and 5 at Alma, Wis., and near Minneiska, Minn. respectively, have been under construction since early this year and will be completed within the next few months. The dams (Nos. 4 and 5) at these sites are now being undertaken, bids having been opened at the end of September and contracts awarded. The contract times on these are 500 days for No. 4 and 550 days for No. 5.

In addition to the completion of these dams, and the entire completion and placing in operation of locks and dams Nos. 4 and 5, the program for which money is at hand also provides for the construction of five additional locks. These are No. 5A above Winona; No. 6 at Trempealeau; No. 7 above LaCrosse, Wis., on the Minnesota side of the river; No. 8 near Genoa, Wis.; and No. 9 near Lynxville, Wis. Bids have been opened for locks Nos. 6 and 7, and detailed plans and specifications are under preparation for the remaining three structures, with a view to advertisement for their construction within the next month.

Funds for this program have been made available by the Public Works Administration, the first allotment of $6,800,000 from the initial $11,500,000 allotment of the PWA for the nine-foot channel. The second allotment of $7,100,000 received recently provides for the construction of five locks and miscellaneous other work pertinent thereto. This work is in charge of Major Dwight F. Johns, Corps of Engineers, District Engineer, St. Paul, Minn.

In the Rock Island district, (Major R. A. Wheeler, District Engineer, Rock Island, Ill.) bids are to be opened on eight locks at intervals up to Jan. 3. These locks are located at Muscatine, Quincy, Burlington, Saverton, Dubuque, Bellevue, Guttenberg and LeClaire. As stated both locks and dam at Rock Island are aproaching completion and in partial operation.

Centralized Sewage Disposal Recommended in Rhode Island

Establishment of a centralized sewage disposal plant on Prudence Island to treat pollution entering Narragansett Bay was recommended to Gov. Green of Rhode Island on Oct. 24 in a report of the Metropolitan Sewer Commission. The board advised the formation of a metropolitan sewerage district including Providence and 17 other communities, in which reside about 87 per cent of the state's population, and the continued utilization of the sewage treatment plants at Providence and Woonsocket, as well as the isolated one at East Greenwich.

Industrial wastes requiring treatment now represent a flow of about 20 m.g.d. coming from about 20 mills, and containing organic polluting material equivalent to the sewage from a population of 370,000.

The recommended plan replaces the treatment works near Warwick Pond and Riverside by trunk sewers, pumping stations, force mains and treatment works on Prudence Island, and provides two trunk sewers from Woonsocket to pumping stations on the east and west sides of Narragansett Bay; force mains from these two main pumping stations to Prudence Island; chemical precipitation and filtration works on the latter land with piping for the delivery of sterilized sewage into deep water east of the island and provision for sludge disposal. The report stated that the district project for works on Prudence Island allows full advantage to be taken of the capacity of the activated sludge plants at Providence and Woonsocket and protects them from the disturbing influence of mill wastes.

Morris L. Cooke Made Head of Mississippi Valley Committee

Appointment of Morris Llewllyn Cooke, consulting engineer, Philadelphia, Pa., to be chairman of the Mississippi Valley Committee, has been announced by the Public Works Administration. Other members of the committee, appointed some weeks ago, are Charles H. Paul, Dayton, Ohio; Herbert S. Crocker, Denver, Colo.; Sherman Woodward, Iowa City, Ia.; H. Solon Graves, New Haven, Conn.; Harlan H. Barrows, Chicago, Ill.; and Maj. Gen. Edward M. Markham, Chief of Engineers, U. S. Army. Donald L. Bower is secretary of the committee.

The object of the committee is to correlate and coordinate the various projects which have been recommended to the PWA for the development of the Mississippi Valley and its tributaries. Problems of flood control, power, navigation, reforestation and soil erosion are being studied by the committee.

Mr. Cooke is a trustee of the Power Authority of the state of New York and at one time was director of the department of public works of Philadelphia. During the World War he served as a member of the War Industries Board and subsequently as a member of the Shipping Board and the Depot Board of the United States Army.

Bids Opened Soon for New Work on New York Triborough Bridge

The Triborough Bridge Authority, New York, has announced that bids for the towers and for the anchorage cable bents will be opened on November 16. This work is to cost about $1,700,000. Recently the Public Works Administration authorized a loan of $35,000,000, and a grant of $7,000,000 to the Triborough Bridge Authority, in order that construction of the bridge could be resumed. It connects the boroughs of Bronx and Manhattan with Long Island by a suspension bridge over Hell Gate near the Hell Gate bridge.

Preliminary Studies Under Way For Dam No. 3 on the Tennessee

Preliminary studies by the Tennessee Valley Authority of the site of Dam No. 3 on the Tennessee River, the first above the Wilson Dam at Muscle Shoals, indicate that a 50-ft. height will be adopted. This will require a 6,000-ft. dam and create a lake having a superficial area of nearly 100 square miles, as compared with the 83 square miles of the Cove Creek reservoir when the latter is full. The slack water above Dam No. 3 would extend 88 miles upstream to a point 5 miles above Guntersville, Alabama.

No details of the plans for the dam will be available until the project can be studied by J. L. Savage, of the U. S. Reclamation Service, who has been loaned to the Tennessee Valley Authority to design the structure.

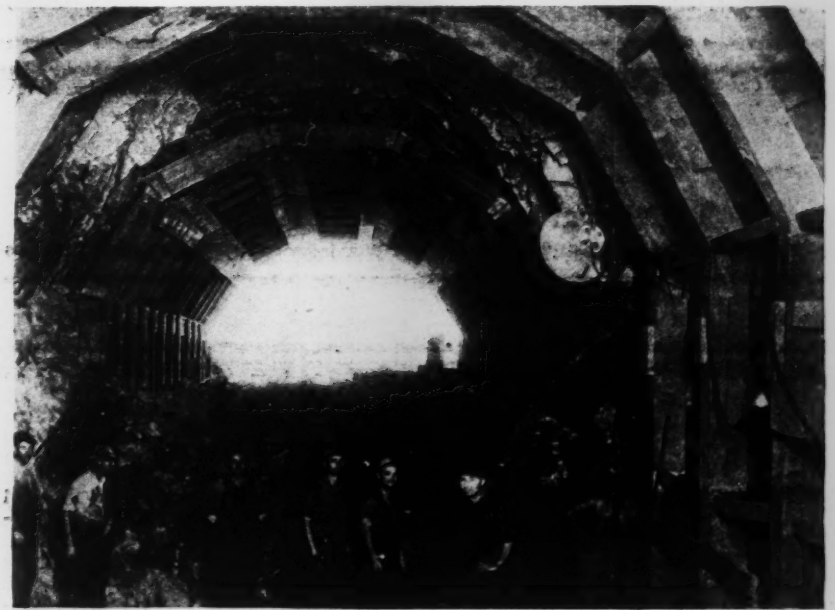
Contract Let for Highways To Site of Cove Creek Dam

Contract for the construction of a heavy-duty reinforced concrete highway from Coal Creek, Tenn., to the west abutment of Norris Dam, near Cove Creek on the Clinch River, has been let to W. W. Boxley & Co., Roanoke, Va., by the Tennessee Valley Authority. The contract is for $256,233 and the work is to be completed within 69 days of execution.

When construction of the dam was first authorized, it was expected that a construction railway line would be built from a connection with the Southern R.R. at Coal Creek to the site, but subsequently it was decided to substitute a heavy-duty highway that could be made a part of the permanent highway system of the region. The new highway will be 4.8 miles long and will have a 20-ft. pavement. A right-of-way 200 ft. wide has been acquired to protect the highway from encroachment and it will be planted with native trees and shrubs.

Construction of bunk houses at the camp site is in progress, the foundation cribs for the temporary construction bridge across the river at the dam site have been completed and the test tunnel leading from the bottom of the exploratory shaft on the west side of the river had been advanced a short distance under the river by the first of November. Orders have been placed for construction equipment and trucks.

A contract for 675 miles of aluminum electrical cable, steel reinforced, has been awarded to the Aluminum Company of America by the Tennessee Valley Authorities on a bid of $400,149.



Acme Photo

FIRST OF COLORADO RIVER AQUEDUCT TUNNELS HOLED THROUGH

The Wide Canyon No. 2 tunnel, 790 ft. long, is the first of the 29 tunnels on the Colorado River aqueduct to be holed through. This tunnel is one of the ten being driven by the Metropolitan District with its own forces, all ten being located in the Coachella Mountain range and aggregating 33.3 miles in length. Of the remaining nineteen tunnels, totaling 57.8 miles in length, all but one have been placed under contract. Bids have twice been rejected for the driving of the East Eagle Mountain bore, 1.79 miles long. The Wide Canyon No. 2 tunnel is being built under the direction of R. B. Diemer, division engineer of the Metropolitan District. R. L. Bryant is tunnel superintendent. F. E. Weymouth is general manager and chief engineer of the district.

Contractor Files Large Claim For Work on Prettyboy Dam

The J. A. Laporte Corp., Baltimore, has filed a claim with the Public Improvement Commission, Baltimore, for $573,501 in connection with the construction of Prettyboy Dam for the city. The company states in the claim that the items making up the total "constitute the contractor's claim for loss and damages sustained by the contractor in the execution of its contract." J. Alan Fledderman, chairman of the commission has appointed a special committee to make a study of the claim. This committee is composed of Bernard L. Crozier, chief engineer of the city; John H. Gregory, consulting engineer to the commission, and Charles Brown Cornell, the commission's supervising engineer on the dam project.

Ship Canal Across Florida Put Up to PWA for Financing

Construction of a ship canal across the upper end of the Florida peninsula to form a new and shorter route from the Atlantic seaboard to the Gulf of Mexico has been proposed to the Public Works Administration for financing under the Recovery Act by the Atlantic Ocean to Gulf of Mexico Canal Commission, Atlanta, Ga. The canal would be a lock canal about 166 miles long, partly in Georgia and partly in Florida. Except at the locks it would have a bottom width of 200 ft. and a depth of 38 ft. Its cost is estimated at $138,000,000, including interest on construction. Work on the canal could be started within thirty days after the approval of a loan, according to the commission, and would require 3½ years for its completion.

The Atlantic Ocean to Gulf of Mexico Canal Commission was created by an act of the general assembly of the State of Georgia, approved Aug. 24, 1929. The commission estimates that during the first year of operation 43,500,000 tons of freight would be handled through the canal and that by the year 1945, this amount would be increased to 69,000,000 tons. Savings to shipping by using the canal to reach the Gulf of Mexico are estimated to amount to $12,264,000 in the first year, and $19,787,000 in the year 1945. Tolls for the first year are estimated at $8,176,000 and $13,192,000 for the year 1945. Operating costs are placed at $2,000,000 a year.

The canal would leave the Gulf of Mexico in Apalachee Bay near Scanlon, Fla., and through a series of four locks would reach a summit elevation ranging from 114 to 108 ft., and would continue across the peninsula in a nearly straight line, using part of the channel of the Suwannee River, and passing through Okefenookee Swamp to Folkstone. From that point two routes are proposed for the descent to the Atlantic Ocean, either by the St. Marys River or through the Satilla River.

The W. S. Lee Engineering Corp., Charlotte, N. C. and New York, is acting as consulting engineer to the commission.

Following a conference between the promoters of the canal project and President Roosevelt on Oct. 30 it was announced that the President had asked the army engineers to make a study of the project.

SOCIETY CALENDAR

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual meeting, New York, Jan. 17-20, 1934.

AMERICAN TOLL BRIDGE ASSOCIATION will hold its annual convention at Cincinnati, Ohio, Jan. 26-27.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, meeting of governing and advisory board, Willard Hotel, Washington, D. C., November 13-14.

HIGHWAY RESEARCH BOARD, National Research Council, Washington, D. C., Dec. 7-8.

NORTH CAROLINA SECTION, AMERICAN WATER WORKS ASSOCIATION and the NORTH CAROLINA SEWAGE WORKS ASSOCIATION will hold their annual joint convention at the Vance Hotel, Statesville, N. C., November 13-15.

THE VIRGINIA WATER AND SEWAGE WORKS ASSOCIATION will hold its fifth annual conference at the Hotel Warrick, Newport News, Va., November 16-18.

ENGINEERING COUNCIL OF FOUNDER SOCIETIES, Los Angeles, Calif., has elected Donald M. Baker as president for the ensuing year. Other officers are Ralph W. Lawton, vice-president, and J. E. McDonald, secretary.

Brief News

A PROPOSED BOND ISSUE of $420,000 for earthquake repairs to school buildings of Santa Monica, Calif., and for a construction program designed to reduce the earthquake hazard to the buildings, failed to pass at an election held Oct. 24. The vote was 5,008 yes and 4,094 no, failing of the necessary two-thirds majority.

EXCEPTIONALLY LOW WATER in the St. Lawrence between Lake Ontario and Montreal has resulted in an order from the Department of Railways and Canals to reduce the draft of vessels operating between the Great Lakes and Montreal to 13 ft. 6 in. Normal draft is 14 ft. On Aug. 24, the Department reduced the draft to 13 ft. 9 in.

AN ALLOCATION OF $250,000 by PWA for a 5,000,000 gal. storage reservoir and an elevated storage tank in a residential district of Evanston, Ill., has been rejected by the city council because of such serious opposition to construction of the elevated tank. Subsequently the council voted to apply for $150,000 for the reservoir which PWA indicates will have to be started as a new application.

A COMMITTEE OF ENGINEERS AND ARCHITECTS, made up of representatives of the Baltimore Engineers Club, American Institute of Architects and the Building Congress, has been formed in Baltimore to make a study of plans to replace the "blighted areas" of the city with low cost housing facilities. The committee, of which W. W. Emmart is chairman, has been named at the suggestion of Abel Wolman, engineer for the PWA in Maryland and chief engineer of the Maryland State Department of Health.

A CANTILEVER BRIDGE across the Hooghly River, connecting Calcutta with Howraw, India, is planned and the commissioners of the port of Calcutta have authorized the government of Bengal to call for bids. The estimated cost of the structure is about $8,300,000. According to the plans, the bridge will carry street car lines, a 21-ft. roadway and two 15-ft. sidewalks. The pontoon bridge which will be replaced by the new cantilever structure is said to be the largest of its kind in the world.

New River Case Re-hearing

The Appalachian Electric Power Co., on Nov. 1, applied to the Circuit Court of Appeals at Asheville, N. C., for a re-hearing of its suit against the Federal Power Commission on the ground that the court in its recent order dismissing the suit had exceeded its jurisdiction. The suit is concerned with the issuance of a permit to the power company for its proposed development on the New River. It was brought to test the Federal Power Commission's claimed right to exercise jurisdiction over power developments on non-navigable streams. News of the earlier court decision was published in our issue of October 19, p. 486.

Personal

D. D. KINNEY, who has been filling the positions of city manager and city engineer of Porterville, California, has resigned as engineer but will continue as city manager.

JOHN BROADUS HOLT, former superintendent of the Vicksburg National Military Park, Vicksburg, Miss., has been transferred to office of the Construction Quartermaster at Fort Benning, Ga.

WILLIAM L. THRAILKILL, formerly assistant chief engineer, state department of public works, Olympia, Washington, has been made engineer for the Washington Water Power Company in Spokane.

FRANK W. CHAPPELL, formerly with the Elrod Engineering Co. and with R. J. Dewees Co., Dallas, Texas, has opened an office for the practice of consulting engineering in Dallas. Mr. Chappell will specialize in structural and municipal engineering work.

LIEUT.-COL. MAX C. TYLER, district engineer, U. S. Army, Buffalo, N. Y., has been appointed division engineer of the Great Lakes Division to succeed Major-General Edward M. Markham, recently appointed Chief of Engineers. Col. Tyler will make his headquarters in Cleveland.

H. B. HOUGHTON, for the past five years on the building code committee of the Department of Commerce, has been appointed a member of the staff of the American Standards Association. Mr. Houghton is a graduate of the University of Vermont and has been with the Building Code Committee since 1928.

F. H. COTHRAN, formerly in charge of engineering and construction activities on the Beauharnois power project on the St. Lawrence River above Montreal for the Beauharnois Construction Co., has been succeeded by M. V. SAUER. Mr. Cothran has been retained by the company as consulting engineer. Mr. Sauer previously was hydraulic engineer for the company.

COL. J. L. H. BOGART, Director of Engineer Services, National Defense Headquarters, Ottawa, Ont., Canada, has been appointed camp engineer at the Petawawa Military Camp. He has been succeeded by LIEUT. COL. E. J. C. SCHMIDLIN, who has been serving as senior professor at the Royal Military College, Kingston, Ont.

EDWARD A. BYRNE, chief engineer of the Department of Plant & Structures, New York City, has been retired in order to

become chief engineer of the Triborough Bridge Authority, a state body set up to complete the Triborough Bridge at New York.

C. I. GRIMM, principal engineer in the office of the district engineer, U. S. Army at San Francisco, Calif., has been assigned as chief engineer of the Bonneville power and navigation dam on the Columbia River. Mr. Grimm will make his headquarters in the district engineer's office at Portland, Ore.

H. L. FREUND has joined the engineering staff of the Tennessee Valley Authority. Formerly Mr. Freund was a vice-president of the Fargo Engineering Co. During the prosecution of the flood control work of the Miami Conservancy District at Dayton, Ohio, he served as assistant chief engineer during the construction of the Taylorsville Dam.

C. MARSHALL FINNAN, an engineer of the National Parks Service, has been appointed to the newly-created position of superintendent of National Capital Parks. For the past two years he has served as superintendent of the Mesa Verde National Park in Colorado. FRANK T. GARTSIDE has been appointed assistant superintendent. ERNEST P. LEAVITT succeeds Mr. Finnan, coming to his new work from the Hawaii National Park, and EDWARD G. WINGATE, formerly an engineer in the Geological Survey on mapping in Hawaii, has been appointed to succeed Mr. Leavitt.

Obituary

JOHN C. GALBREATH, retired consulting engineer of Knoxville, Tenn., died in Memphis on Oct. 22, age 70 years.

DENNIS E. COLEMAN, president of J. C. Coleman & Sons, contractors, Boston, died at his home at Newton, Mass., Oct. 16, following an illness of several months.

PHILLIP HOLMAN, city engineer of Auburn, Ind., for the past 12 years, died there recently, age 58 years. Previous to his work with the city, Mr. Holman was superintendent of the Toledo and Chicago Interurban Co.

WILLIAM BLAISDELL PLUMER, for many years a civil engineer connected with the Mutual Fire Insurance Association of Boston, Mass., died at his home in Melrose on Oct. 26. He was born at Portsmouth, N. H., 64 years ago, and was educated at Dartmouth College, graduating in the class of 1896.

WILLIAM T. LYLE, head of the department of civil engineering at Washington & Lee University, Lexington, Va., died at Lexington on Oct. 30, age 58 years. Mr. Lyle was a native of Utica, N. Y., and a graduate of Princeton in the class of 1896. From 1902 to 1907 he was an instructor at the University of Pennsylvania and from 1907 to 1918 served as professor of civil engineering at Lafayette College. From 1919 to 1921 Prof. Lyle served as lecturer at Rice Institute, Houston, Texas, and in 1921 became head of the civil engineering department at Washington & Lee University.

HORACE ARRELL BROWNE, 51 years of age, a civil engineer in the service of Baltimore city for many years, died on November 1 at his home in Baltimore. His death was due to pneumonia and came after a short illness. The fueneral was held on November 3.

GEORGE A. RICKER, consulting engineer to the Reconstruction Finance Corporation, died in Washington on Nov. 2, aged 70 years. Mr. Ricker was a native of Portsmouth, N. H., began engineering work on the Erie Railroad, and subsequently studied engineering at Massachusetts Institute of Technology. The major part of his engineering career was spent in and around Buffalo, N. Y., where he began as resident engineer for the Buffalo Creek R.R. and later became chief engineer on the construction of the Niagara Gorge R.R. Subsequently he was with the Buffalo Traction Co., and still later he was deputy commissioner of highways for the state of New York. From 1917 to 1930 Mr. Ricker was with the Portland Cement Association in various capacities. In recent years he had made his home in Washington.

CONSTRUCTION STATISTICS OF THE WEEK

CONTRACT totals this week represent a 4-day week instead of the usual 5-day week due to early closing on account of election. This short week is notable for the small number of contract awards. Accordingly the contract total falls considerably below preceding weeks, $15,255,000 compared with $34,132,000 last week. Federal work is about half of the preceding week's total, state and municipal contracts are $7,000,000 compared with the previous week's $17,000,000 volume. Private work of $2,250,000 compared with $5,000,000.

New capital through commercial purchases of bonds likewise was low and included no large issues. The PWA loans and grants to municipalities, however, were up from $12,873,000 during the preceding week to $17,758,000 this week.

The only large contract awards during the current week were the Texas highway awards totaling $654,111 and contract let by U. S. Engineers, Kansas City, for dredging the Missouri River, $1,836,935.

The number of lettings for which bids are called remains high, averaged, 208 lettings per week in October.

CONTRACTS
(Thousands of Dollars)

	Weekly Average Nov. 1932	Prev. 4 Weeks	Week Nov. 9, 1933
Federal Government	$6,269	$14,938	$6,021
State and municipal	15,479	13,717	6,985
Total public	$21,748	$28,655	$13,006
Total private	3,363	5,384	2,249
Week's total	$25,111	$34,039	$15,255

Cumulative to date:
1932....$1,065,728 1933.....$867,747

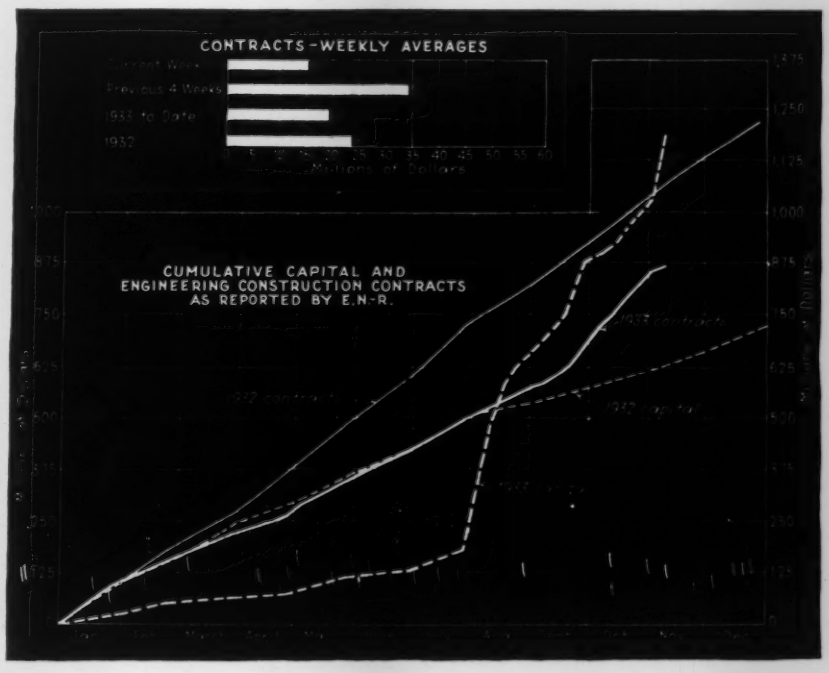
NEW PRODUCTIVE CAPITAL
(Thousands of Dollars)

	Week Nov. 9, 1933	Cumulative, 1933
State and municipal	$660	$269,422
PWA allotments, public	17,758	684,324
Corporate issues	....	48,547
PWA allotments, private	136,349	184,902
Total new capital	$154,767	$1,187,195
Cumulative, 1932..	$633,000	

NOTE: These figures include private bonds and stock sold for productive purposes; state and municipal bonds for construction; R.F.C. advances for self-liquidating loans; PWA loans and grants to states and municipalities, including the special highway funds; and PWA private loans.

INDEX NUMBERS

E.N.R.-Cost		E.N.R.-Volume	
November, 1933	**190.14**	**October, 1933**	**162**
October, 1933....	187.74	September, 1933..	122
November, 1932..	158.20	October, 1932.....	137
1932 (Average)...	156.97	1932 (Average)...	127
1931 (Average)...	181.35	1931 (Average)...	220
1930 (Average)...	202.35	1930 (Average)...	260
1913 (Average).....	100		



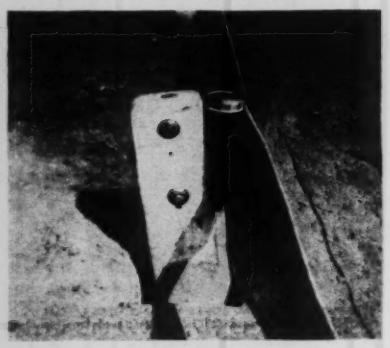
Construction Equipment and Materials

New Highway Guard Made of Steel Plate

A new steel-plate highway guard rail known as the Duraguard has been announced by the Truscon Steel Co., Youngstown, Ohio. It is of resilient construction and is designed to withstand a shock by absorbing the initial blow of a vehicle and then deflecting it to a position parallel to the guard.

When first struck by a car the guard plates yield slightly, then the reflex action throws the front end of the machine back, at the same time straightening the wheels so that the course of the machine is parallel to the guard.

The steel plates are 12 in. wide, of a gage as specified, with reinforced end connections. Plates are furnished galvanized or painted.



"Duraguard" after collision test.

Unless otherwise specified, all sections are standard lengths: intermediate sections, 15 ft. 11¾ in. and end sections, 7 ft. 6 in. These sections require post spacings 16 ft. on center, except the end sections which are 8 ft. on center.

New Equipment in Brief

Bulldozers. Wooldridge Trailbuilders and Bulldozers are now manufactured by the Continental Roll and Steel Foundry Company, East Chicago, Ind., fabricated of "Dynamic" steel, a recent Continental development in steel alloys. It is described as steel that will withstand heavy and continuous shock stresses.

Dragline: The Northwest Engineering Co., Chicago, recently announced a new dragline for which is claimed large capacity with simplicity, mobility and economy. The machine is powered with slow-speed 8x9-in. engine, giving torque characteristics to meet the demands of dragline service. The Northwest-type cushion clutch is provided as standard equipment, and mobility is achieved through the usual Northwest positive traction mechanism.

Portable Generating Set. The Harnischfeger Corp., Milwaukee, Wis., announces a small, heavy duty line of lighting units consisting of a one- or two-cylinder gasoline engine directly coupled to a compound-wound, continuous generator. Push button or manual starting is available. Capacities range from 400 watts to 3 kw., generating 35 or 120 volts direct current. Greater capacities are provided for by 4 and 6 cylinder gasoline generator sets with a current range of 1½ to 60 kw.

Trucks: The Federal Motor Truck Company, Detroit, Mich., has started production on four new six-wheel trucks, two single-drive of 3 and 4½ ton capacity respectively, and two tandem-drive of the same capacities. Featured are distinctive styling and sturdy construction, and the models incorporate the basic Federal 6-wheel design, new and larger power plants, hydraulic brakes on all six wheels. Wheel base lengths for the two 3 ton models are 172", 185", 198"; for the 4½-ton models, 195", 205", 218".

Masonry Drill: Differing from the usual four point masonry drill in construction is the three point masonry drill known as the Rawldrill, manufactured by the Rawlplug Company, Inc., New York, N. Y. Its three point construction, so it is claimed, makes possible several advantages over conventional drills. It permits resharpening of the drill on any grinding wheel; it will drill clean, accurate holes until worn down to the shank; the straight parallel sides of the cutting lip insure an accurate hole. Drills are made in sizes ⅜ in. to 1⅜ in. in diameter and also in different lengths.

Business Notes

NEWHALL CHAIN FORGE AND IRON CO., announce that Harry C. Brown, former vice-president, has been elected president to succeed the late Henry B. Newhall.

R. G. LE TOURNEAU, INC., Stockton, Calif., manufacturers of heavy earth-moving equipment, announce the appointment of J. H. Heinmiller as sales engineer for the inter-mountain district.

THE NATIONAL MUNICIPAL INCINERATOR ASSOCIATION has been organized at the Milwaukee convention of the International Association of Public Works Officials, with ten companies representing more than 90 per cent of the industry, for the purpose of forming and presenting a code of fair competition, and instituting trade association activities within the industry. The present headquarters of the association will be at the offices of the present, 155 E. 44th St., N. Y. C.

New Publications

Heaters. Littleford Bros., Cincinnati, Ohio, have recently issued Bulletin No. 1-3 describing the latest models of their asphalt, and tool-heating kettles.

Roofing. The Ruberoid Co., maker of Ru-Ber-Oid shingles, roofings, and building materials, have issued a new 67-page catalog describing in detail their various products.

Pumps. A new bulletin on side-suction volute pumps has just been published by the Morris Machine Works, Baldwinsville, N. Y. The bulletin describes improvements and types of drive, with rating tables and performance curves for each type.

Crusher. Traylor Engineering and Manufacturing Co., Allentown, Pa., has just published Bulletin No. 2110, covering the Traylor type TZ reduction crusher. This 15-page booklet describes the unique design details of this crusher, and includes parts diagram and list, as well as complete tables of setting dimensions.

Chlorination. "Hypo-Chlorination of Water," a 72-page handbook of water works practice, has just been announced by the Mathieson Alkali Works (Inc.), summarizing a wide range of water works problems, with specific advice for their solution. Emphasis is placed upon the usefulness of HTH as a source of hypochlorite solutions. Procedure is outlined for such purposes as safeguarding of smaller water supplies, eliminating algae troubles, conditioning filters, sterilizing new mains and meeting emergencies. Illustrations and a complete index add to the value of the handbook.

Improved Elevating Grader Gives Larger Capacity

The Austin-Western Road Machinery Co., Chicago, Ill., announces the new Austin elevating grader, improved to give greater flexibility, better balance and larger capacity. Both plow and carrier are operated by hydraulic power control.

To assure flexibility and balance, rubber mountings and cushions are provided at strategic points in the main frame. An arched H-beam frame provides extra clearance for load on the carrier and keeps the center of gravity of the machine at the lowest possible point. The front rails of this arch are widely separated and mounted on a spring platform which permits greater vertical and horizontal oscillation of the front end.

The 42-in. machine is equipped with a 49-hp., 6-cylinder engine, and the 48-in. machine is equipped with a 53-hp., 6-cylinder engine. The 48-in. is provided with an extensible rear axle which can be extended 18 in. to increase the stability of the machine when extra long carriers are used.

New Austin-Western elevating grader.